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LESSONS ON HAND RAILING.

FOR LEARNERS.

BY

R. RIDDELL.

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By Robt. Riddell The Author.

LESSONS ON HAND RAILING,

FOR LEARNERS.

FRANKLIN INSTITUTE LIBRARY.
BY

ROBERT RIDDELL,

AUTHOR OF "THE CARPENTER AND JOINER," "PRACTICAL GEOMETRY," "NEW ELEMENTS OF HAND RAILING," ETC.

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THE addition of another work, to those which I have already published on Hand Railing, might seem a further demand upon the purchasers of former editions. This, however, is not the object; nor do I wish it to appear that this new treatise is indispensable, or that the subject shall receive a clearer elucidation from this than from former works. It is simply a separate and distinct system of lines, the constructive principle differing in every material point from that illustrated in my previous works; and no similar system has ever yet appeared in print. The practical results of both my systems are precisely the same, though produced by opposite means. The student, therefore, having an alternative, may adopt the one he best understands.

The ideas resulting from my experience in Hand Railing have been before the public for many years, and the fact that their principles have been thoroughly tested and generally adopted on both sides of the water is of itself sufficient evidence of their value.

Regarding the merits of a work now presented for the first time, it is eminently proper that, should they be great or small, their enumeration should be made by those interested in becoming fully conversant with the proper combination of geometrical lines requisite in the construction of Hand Railing. Proficiency in this is justly considered the summit of the joiner's art.

R. RIDDELL,
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Philadelphia.

4191

Plate 1

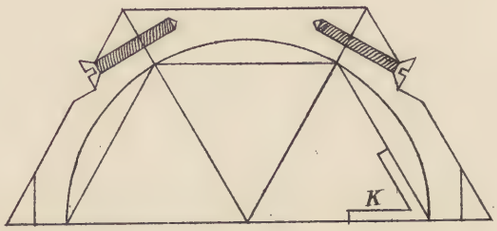

Fig. 1

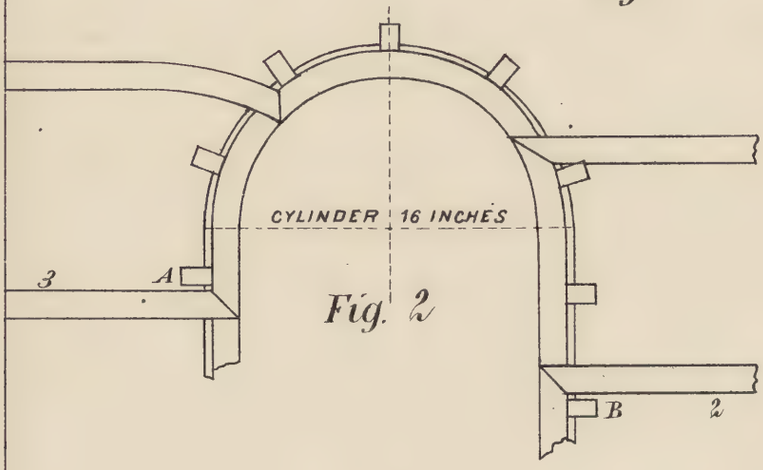

Fig. 2

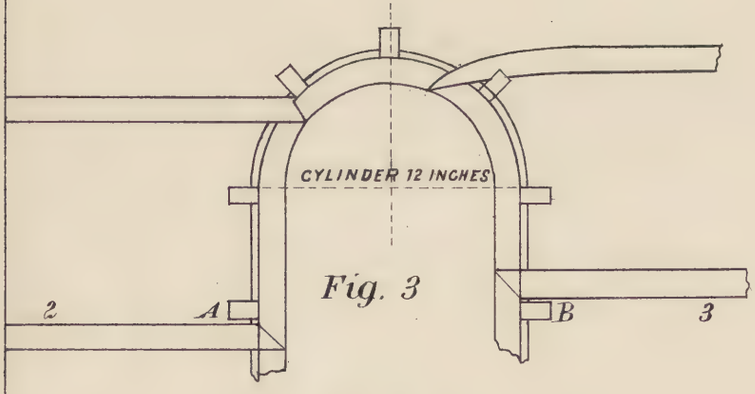

Fig. 3

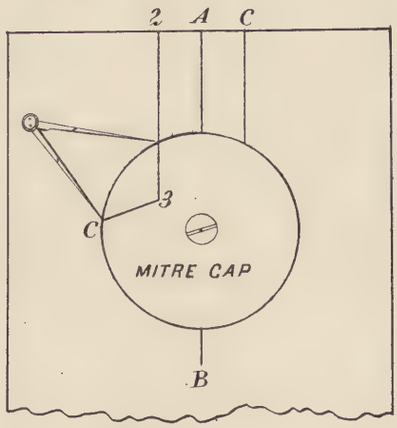

Fig. 5

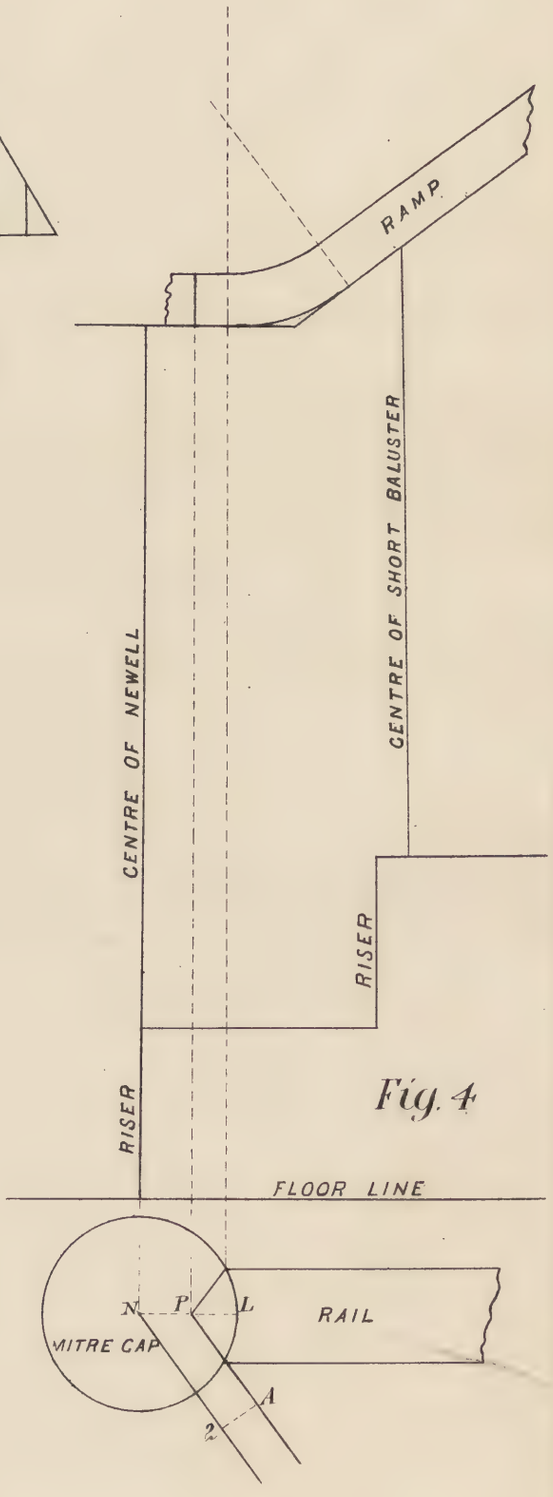

Fig. 4

PLATE 1.

CYLINDERS, RAMPS AND MITRE CAPS.

WE here commence by giving a few of the simplest constructions in stair building; and, in doing so, the learner is supposed to be entirely unacquainted with this branch of art, but at the same time is considered a competent joiner, capable of executing work properly. Then, with no other guide or assistant than the drawings and explanations given in this work, he may thoroughly instruct himself in the principles and practice of stair building. But let it be distinctly understood, that accuracy in both drawing and workmanship is essential to complete success and satisfactory results. This will appear evident in the construction of a simple cylinder, as we will now proceed to show.

Fig. 1. Here the cylinder is formed by three hollow staves. These are glued and screwed together. The usual way is to prepare a stave long enough to make two or more cylinders with the edges jointed to bevel K. This being cut into proper lengths, place the square ends of three pieces on the plan, bringing the joints together. Now if the edges be accurately jointed, they will form a perfect semicircle, agreeing with the plan, and you may proceed to glue and screw the joints. Nails should not be used, as they are apt to make a burr or roughness on the edges and to break the bond of glue.

It may however be stated that this plan of making cylinders is not adopted by workmen generally. Some prefer bending a veneer over a form or drum of the required size, and then gluing a number of staves on the back. This is a very neat method, as the grain of wood may be made to run in the same direction as in the string, which should always be done when the staircase is of walnut or other hard wood. But, if the work is to be painted, a cylinder made as first stated answers every purpose and saves the trouble and expense of making forms or drums.

Fig. 2. The proper effect of curves in a wreath depends entirely on the position of risers, in either platform or other stairs; a correct and simple method of determining this is here shown. The diameter of cylinder is sixteen inches. After drawing centre line of rail, set the compasses to half the width of a step and space off the balusters; three of which stand on the platform as shown. Balusters A and B give a direction to draw risers 2 and 3; from these set off width of steps, which gives the position of risers landing on and starting from the platform as shown.

Fig. 3. In this case the diameter of cylinder is twelve inches: two balusters stand on the platform, and position of risers regulated as in Fig. 2. But if the cylinder is six or eight inches, then face of risers landing on and starting from the platform should stand on spring line or diameter of cylinder.

By adopting these simple directions, time will be saved and the work will present a more finished appearance than otherwise.

Fig. 4 shows the elevation of stairs at the starting, giving centre of newel and position of mitre cap. In forming a mitre for the cap, let L P equal half the width of rail, in preference to what is termed a true mitre. To cut this mitre in the cap at once and correctly, proceed as follows: Draw the required size of cap, and width of rail as shown: then from centre N, draw a line parallel with one side of mitre, which determines a distance as 2 A. Have a piece of plank, shown in Fig. 5; on it draw a line as A B, and set of POINTS 2 and C on each side of it, making the distance between, the same as between 2 A in Fig. 4. From 2 C, draw lines parallel with A B. Square over the end of plank, and with a panel saw cut through these lines, keeping thickness of saw towards A. This done fasten with a screw the centre of cap over line A B, enter the saw and cut one side of mitre down to 3. Set the compasses to width of rail and mark point C as shown. Revolve the cap until point C is opposite cut C in the block; then enter the saw and complete the mitre. Should there be a hole through the cap, let it revolve on a pin set in the block.

PLATE 2.

THE QUARTER CIRCLE WREATH LANDING ON A LEVEL FLOOR.

HERE the first lesson in hand railing begins, by showing the construction of a simple wreath for stairs, having square steps and a quarter circle at landing; the wreath to form its own ramp and connect with the level rail. The under side of rail when in position should stand above the floor to suit a long baluster. But to understand this we must commence by making an elevation of a square step, two risers and floor line, as in Fig. 1. The points H H show centre of short balusters. Let under side of rake rail rest on these. Make under side of level rail stand half a riser above the floor line. Set off thickness of rake and level rail intersecting at B. From this point set off width of rail as D, then through half this width draw a perpendicular, shown by dotted line, cutting through K, and giving centre of level rail and balusters to the right of Fig. 2. The position of riser landing, being already fixed by the elevation, all that is necessary to complete the ground plan is the quarter circle. Its radius may be assumed as L N. Draw a line from N, parallel with L K, cutting rake rail at A. We have now a proper direction to cut the carriage, and exact points for drawing a mould for the wreath, everything being obtained from the elevation.

As all inclined curves, which stand over and agree with a circle are elliptical, it is evident that the curve in the rake or inclined rail, to stand directly over and follow the quarter circle of the stairs, must also be elliptical; therefore this will be the form of a wreath. The operation of describing an ellipse, by means of a string and two pins, is familiar to most joiners.

Fig. 3. This shows how to prepare a mould for giving the wreath its proper form. First draw a base line, and on it set off points A B C, to correspond with A B C on elevation. Draw from point A a line at right angles with base. Set off on this line, from A, points E D, having them correspond with E B D on elevation. Take A B for radius or half diameter, and with E for centre, intersect the base line; which gives points 2 and 3. Fix a pin in each of these. Tie a string to pin 3, bring it around pin 2 and with a pencil stretch it, touching the point E; then strike the curve from E to B. This done take A C for radius, and with D for centre, intersect the base line, giving points for pins as shown; from which sweep the outside curve from D to C. Let three or four inches of straight wood remain on the mould below B C, and any length desired on the left of E D.

The plank for a wreath should be as thick as the rail is wide. Lay the mould on and mark by it. Cut the plank square through. Face the top surface out of wind, and work the edge D square with the surface. Run a gauge line to half thickness of plank on the edge, and square over from D, cutting the line at A, as shown in the figure below. Now with the pitch board or bevel, mark the spring line D A D. Work both sides of the piece by the mould. The application of mould is to keep point D opposite spring line on edge of plank.

This gives lines for taking off the slabs.

The cylinder part of wreath being formed, gauge the straight part on the left of E D, to thickness of rail. Cut off the under slab to near the spring line, and the top slab on the wide end, square with joint. This slab is shown in elevation as B C D. It will now be seen that the concave corner of the piece gives a perfect direction for taking off the remaining slab; thus forming the best possible ramp on top side of wreath landing; every part is parallel and the same width as rail. Let the learner remember, however, that to obtain these results, he must be exact in both working and drawing. Now complete the wreath by gauging to a thickness.

Fig. 4 shows the elevation of square steps and risers, and gives the proper manner of taking the lengths for a rail. It is very natural to suppose, that the height of riser and width of step gives pitch of stairs, and it undoubtedly would, provided there were no errors. But it is quite possible that a landing might be fixed a little high or low, or perhaps a wrong cut made in the carriage at the starting, either of which mistakes would give a very different pitch. There was a time when such errors would have made no difference; then joints were made and fitted on the stairs, wreaths rudely cut and worked over cylinders, and little or nothing known to guide or direct the workman, and yet the hand rails of olden time present a finish and excellence truly wonderful, considering the disadvantages under which the workmen of that time labored. But now hand railing is reduced to an exact science, everything should be prepared on the bench, and made ready for fixing. This, however, cannot be done without having correct dimensions, the pitch of stairs being the most important. To obtain this, lay a straight edge on the nosings and mark a plumb line on its face as shown. This gives the pitch, regardless as to how the work has been put up.

The lengths of straight rails is obtained by laying a rod on the nosings, and marking a plumb line for face of second riser as R, and spring line of cylinder as P. The necessity for marking the spring line on every piece of wreath having any portion of straight wood is this: The line is first marked on the edge and continued across the under side, so that on fixing the rail and having it in a true position over the plan, the spring line of both cylinder and wreath should stand exactly opposite or be on a plumb line.

Plate 2

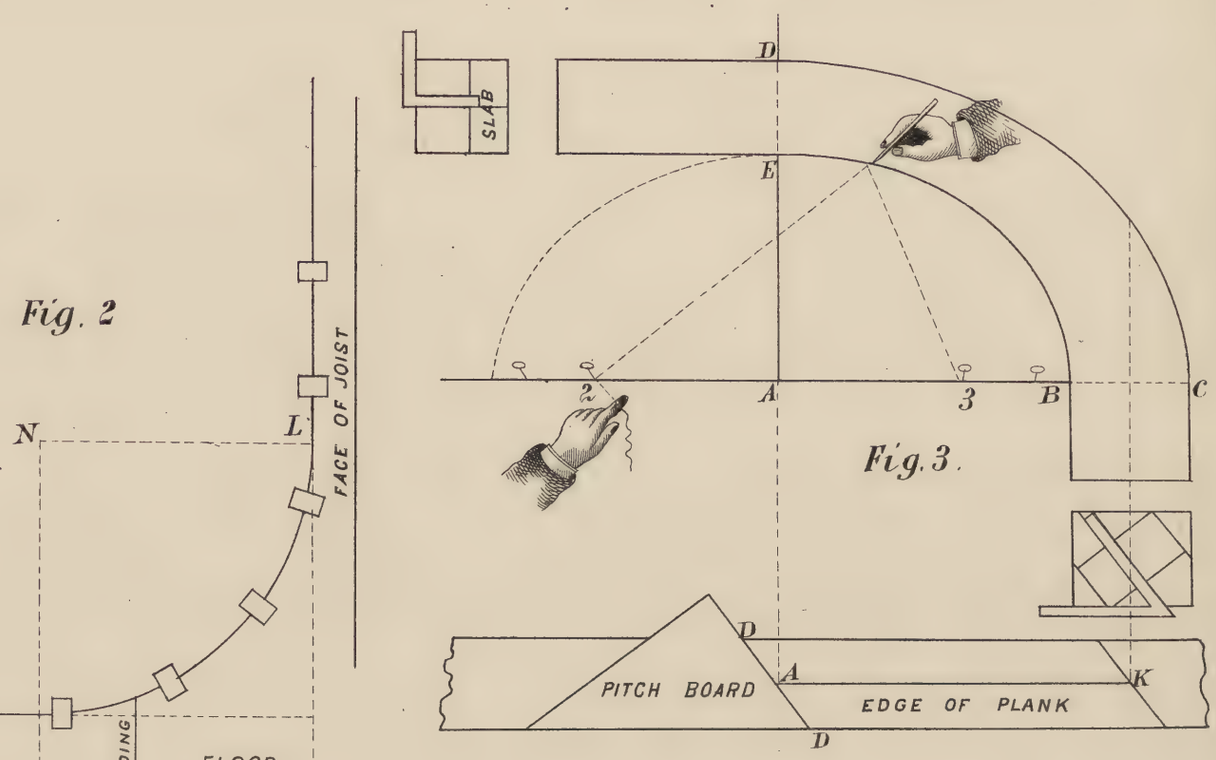

Fig. 3.

Fig. 2

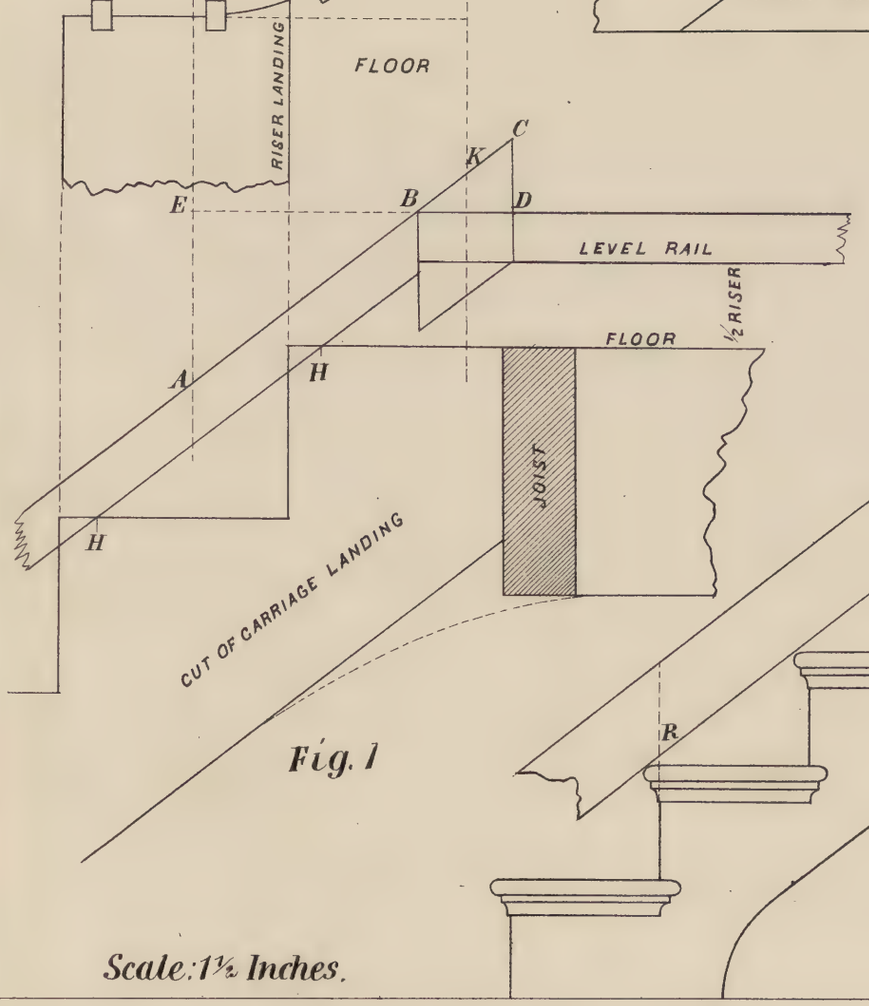

Fig. 1

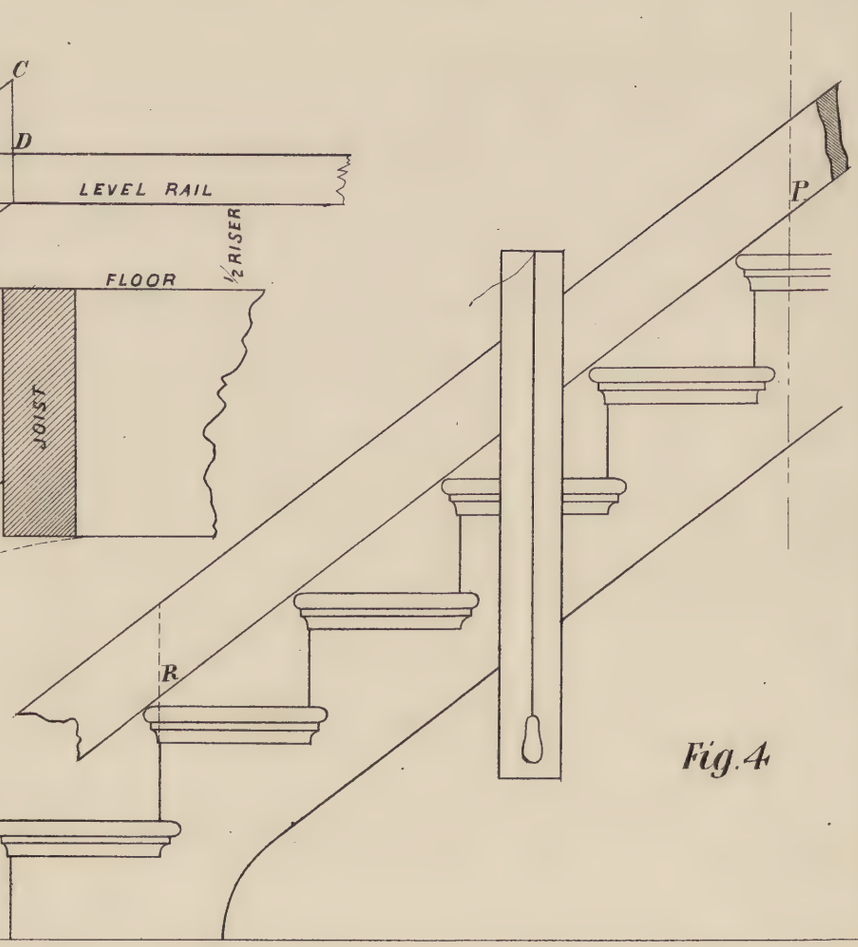

Fig. 4

Scale: 1½ Inches.

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Plate 3

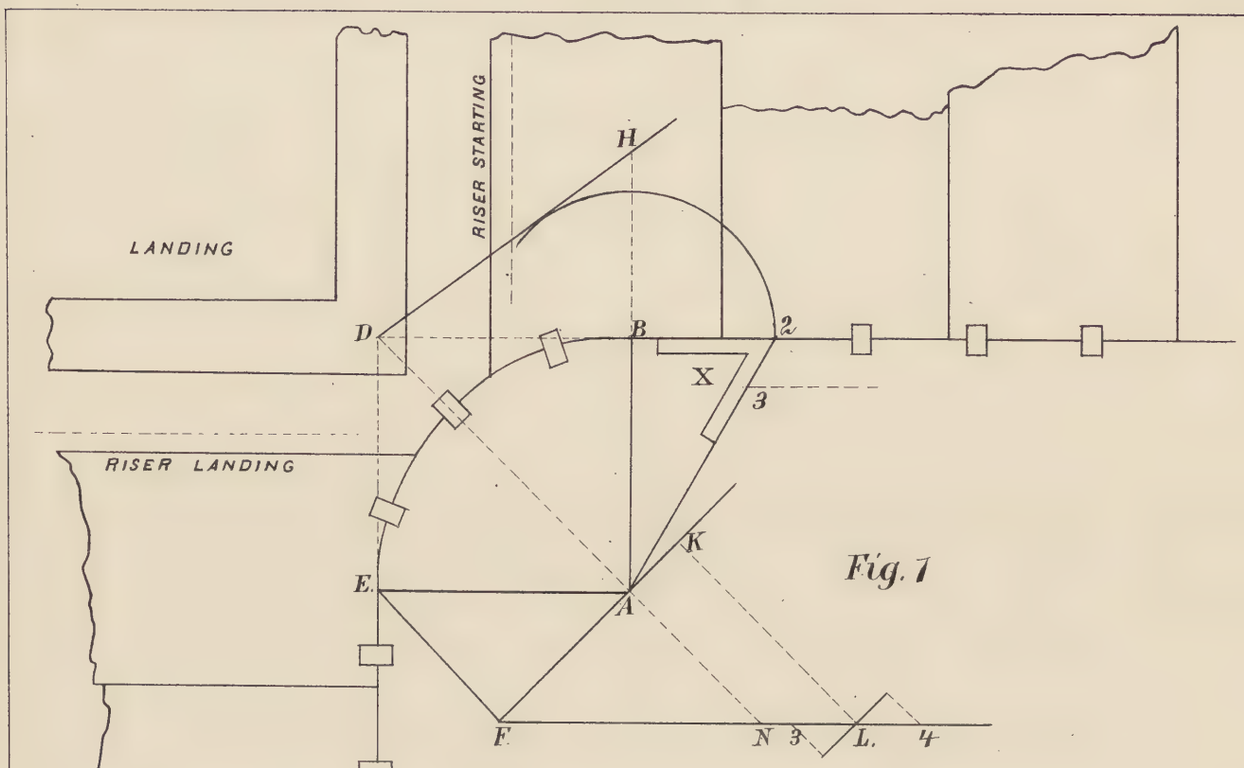


Fig. 1

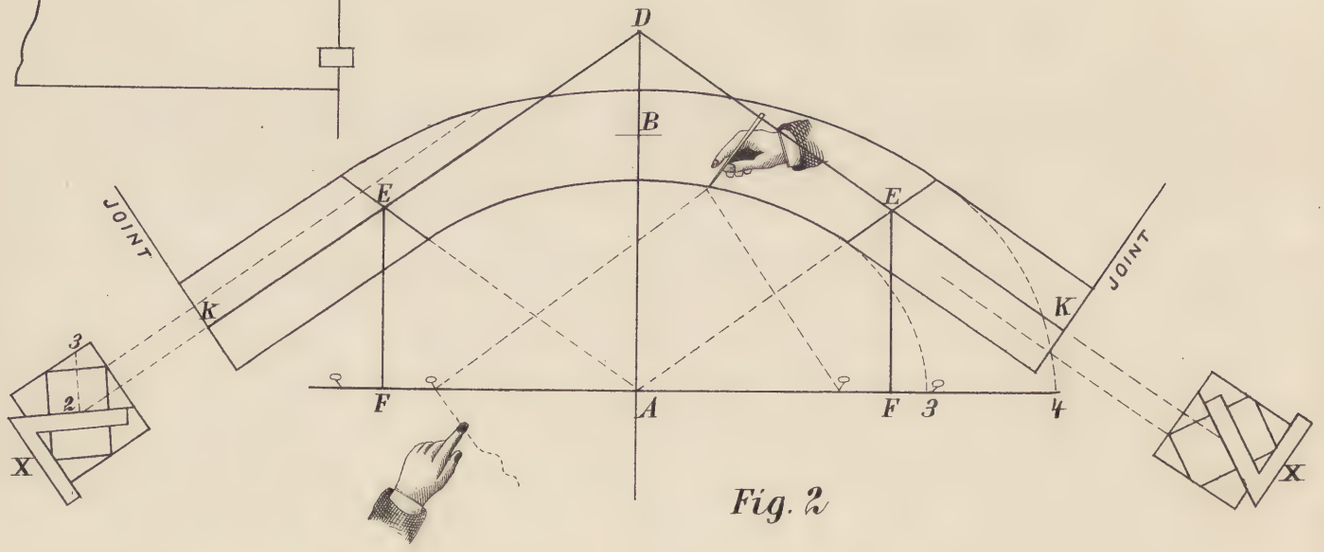
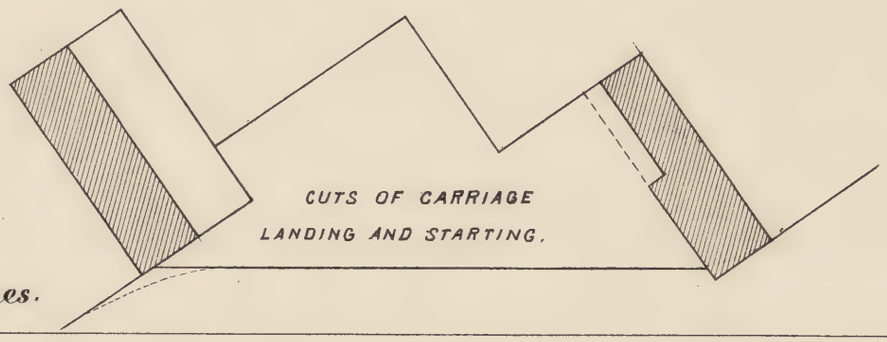


Fig. 2



CUTS OF CARRIAGE
LANDING AND STARTING.

Scale 1½ Inches.

Plate 3.

THE WREATH FOR QUARTER LANDING STAIRS.

In laying down a ground plan for stairs of this description the proper way to proceed is to place the risers in such a position at the cylinder as will cause the surface of plank for wreath to be thrown on the same inclination as that made by a square step and riser; or, in other words, the straight portion of wreath and straight rail should have same pitch.

Fig. 1 shows this arrangement. Draw two sides of a square as E D B, the continuation of these sides being the centre line of straight rail. Set off on each side from D half the width of a step. From these points draw risers landing and starting; spacing from these the width of steps. The radius for centre line of rail may be assumed, as A B, or drawn so that nosing on step starting will clear the baluster on the landing. The ground plan being now complete, we will proceed to find a mould for wreath. To do this lay the pitch-board on line D B and draw from D, giving pitch D H; extend line A B cutting at H. This gives B H as half the height of wreath. Now draw from D through A, and from E parallel with D A. Draw a line square with D A from A to F. Make A N equal B H, and draw from F through N. This line gives pitch of plank. In order to strike the curves on mould with a string, as in preceding example, we must find half the long diameter of semi-ellipse, which is done as follows: Make F K equal A B. Square up from K, cutting at L. Draw through L parallel with F K, and set half width of rail on each side of L, cutting the pitch line at 3 and 4. This gives F 3 as half the long diameter for inside curve of mould, and F 4 for outside curve. To find a bevel for joints of wreath: From B as centre and a radius touching D H strike an arc cutting at 2, join 2 A. This gives bevel X for the joints. It will also give half the width of mould on its straight part. For example, set half width of rail below B 2, cutting the bevel at point 3. This gives 3, 2 for half width of mould.

Fig. 2 shows the manner of finding the mould. Have a piece of board sufficiently wide. Square over any line as A B D. Make A D equal A D on plan. Make the distance A F on right and left equal F N Fig. 1, square over the lines, make F E right and left equal F E on plan, draw from D through E, E. These are tangents on the mould, and to be correct must equal the pitch D H on plan, make A B equal A B on plan. Set half width of rail on each side of B. Make A 3 4 equal F 3, 4, Fig. 1. Find points for pins by the method already given, and strike the curves with a string, dress to the lines and the mould is complete. Cut the plank square through, and face one side out of wind. Lay on the mould, and mark the joints, and at the same time mark on surface of plank the direction of lines E K. The object of having these lines is to prove the correctness of a joint at once, by the application of a square which should be perfectly true and the blade nine or twelve inches long.

Place the stock against the joint, and the edge of the blade along the surface of the stuff. If the joint be cut square the edge and surface will agree. To prove the other direction, place the stock against the joint, and lay the blade flat on the surface; when, if the joint be correct, the edge will agree with line E K. By this manner of applying the square, the slightest inaccuracy will be readily noticed, because we have a surface, or line the entire length of the blade to prove by.

The joints being made, apply bevel X, and mark square section of rail on each joint, remembering to reverse the bevel, as shown on the right and left of Fig. 2. Take off the outside slab on the left, indicated by the dotted line. Work it by bevel X and square with joint. When this is done, apply a square to the beveled edge, and from half the thickness of stuff, as 2, square over 2, 3. Continue this line along the beveled edge, and square with joint. Set off on this line the distance between E, K on mould; and through the point thus given, draw spring line by the pitch board. The slab on the right is taken off, and spring line on edge, marked in the same manner.

Lay on the mould, keeping its outer edge fair with the beveled edge of stuff on the left, and its inner edge fair with dotted line on the right. Mark the surface of the stuff by the mould, turn the piece over and mark the under side in the same manner. This gives a guide for taking off the slabs, and, in doing so, hold the plane in the direction indicated by the spring line on the beveled edge.

The wreath having now its cylinder form, take off the upper and under slabs, as directed by the square section of rail on each joint. This is best done by sawing down to near the spring line; but to have a still further direction, square over the line through B on both edges. Mark half thickness of stuff, and on each side set off half thickness of rail; we have now clear directions for cutting off the remaining slabs, which completes the wreath.

The method of applying the mould as explained in this case should be adopted for all others, therefore need not be repeated.

PLATE 4.

THE SEMI-ELLIPSE AND THEORY OF JOINT BEVELS ILLUSTRATED.

THE curves on all face moulds for wreaths being some portion of a semi-ellipse, it is necessary for the stair builder to become familiar with the manner of describing this figure. While, perhaps, few workmen are entirely ignorant of this beautiful problem, for its application is common in many trades, there may be some readers of this work who are unacquainted with it, and to those we will briefly explain the simplest and most practical manner by which it may be done. The means are always at hand, being simply a string and two pins.

Fig. 1. The semi-ellipse has two diameters, always at right angles with each other. These are termed major and minor axis, meaning long and short diameters. In this Fig. the line C B represents the major axis, and A D the minor axis. We desire now to describe a semi-ellipse of a given length and rise. Let C B represent the given length, and A D the given rise. Take one-half the major axis or long diameter (which is the term we shall use hereafter), as A B or A C, for radius; and from D as centre, intersect the long diameter on the right and left. This gives points H and K. Fix a pin in each of these, tie a string to pin K and bring it around pin H. With a pencil stretch the string until its point touches D. Strike the curve from D to B, and returning to D, complete the curve to C. To arrive at correct results, the hand should be steady, the string fine and not allowed to stretch. Should the curve appear defective from any cause, the error may be detected in the following manner: From the end of a rod mark the short diameter A D, and half the long diameter A B, by moving the rod and constantly keeping these points, S and T, on the long and short diameters, the end of the rod R will give any number of points, through which the curve, to be correct, must pass.

The most important point, and the one upon which the claim of stair building as an exact science rests, is the principle by which correct bevels for joints are determined from the plan. This principle is not only reliable, but applicable to all forms of wreaths, and when once understood, its simplicity and correctness will be self-evident. We shall now illustrate the theory of the joint bevels, starting with the proposition, that all inclined rails, to follow the directions of, and agree with, a circular plan directly under them, must be elliptical in form. This is proved by cutting a semicircle on the rake, showing the section thus made to be a perfect semi-ellipse.

Fig. 2. The two semicircles in this Fig. represent the base of a cylinder; the line through A to the right and left its diameter, and Y U its thickness. Assume A B C as the rake cut, through the cylinder, and transfer points B C from it to line of diameter. Then find points for pins by the method already given and sweep the two semi-elliptic curves as shown. This semi-ellipse is an exact section of the cylinder, and when raised to its proper position will stand directly over the semicircle. Bevel X in the angle at B gives the plumb cut at each end.

Let us now proceed to find tangents to a portion of the semicircle. From A as centre strike a semicircle, as the dotted line passing between Y U. On this fix upon any points, as 4 and 6, and draw lines from these parallel with diameter, to the centre of semi-ellipse on the right and left. This gives 5 and 7. At right angles with 4 A, draw a line from 4, cutting the perpendicular at T; also draw from 6, square with 6 A, cutting at S. From points S and T draw lines through 5 and 7. These lines are tangent to elliptic curves at these points, and give the direction for any straight wood that may be necessary on the right and left. Draw a line from A, through 5 and 7, and we will proceed to find the bevel for joints on straight wood. Before going any farther, it may be again stated that the plank from which a wreath is to be cut should be as thick as the rail is wide. For example, if the rail is four inches wide the wreath should be cut from a plank four inches thick.

Fig. 2. Let Y U represent the thickness of cylinder, and also the width of rail. We therefore take that for the thickness of plank from which to cut the wreath. This is shown on the right and left, marked EDGE OF PLANK. From the points where the tangents intersect the diameter, 3 on the left and C on the right, square up to half the thickness, shown on the edge 2, 2; then taking bevel X from the angle B, apply it as shown. This gives J and N on the lower edge of plank. From these points square down to the diameter, shown at F on the left and L on the right. Then from F and L draw lines along the straight wood and parallel with tangents, cutting the lower edge of plank at P and H. Half the thickness of plank is marked at these places as K and R. By drawing a line from P through K, and from H through R, we obtain bevels N and W for the joints of straight wood. Although these bevels differ from X, yet bevel X was the key by which they were found, and which also suggested the diagrams at Fig. 3 and 4, giving the same results in a more direct and practical manner, and proving them to be correct.

Fig. 3. Draw a line parallel with diameter in Fig. 2. Fix a point, say B. Draw from it line B K, parallel with tangent 3 K on the left in Fig 2. Turning to the angle in which is shown bevel X, take point B for a centre and with any radius draw dotted arc O O. With the same radius, and with B in Fig. 3 for centre, draw arc O O; make its length equal arc in Fig. 2, and from the lower point O draw a line through B. Then from any point, as V, square up a line, giving D. Now with V for centre, strike an arc, its radius touching B K and cutting at E. From D draw through E, and we have bevel N, corresponding exactly with bevel N Fig. 2, and proving it correct.

Fig. 4. Draw line B K parallel with tangent 7 R in Fig. 2, and proceeding as in Fig. 3, and we have bevel W; which is equal to bevel W on the right. These problems have never been given before, and are well worth the study of the learner, as a thorough familiarity with them will materially assist him in mastering the principles of hand railing.

Plate 4

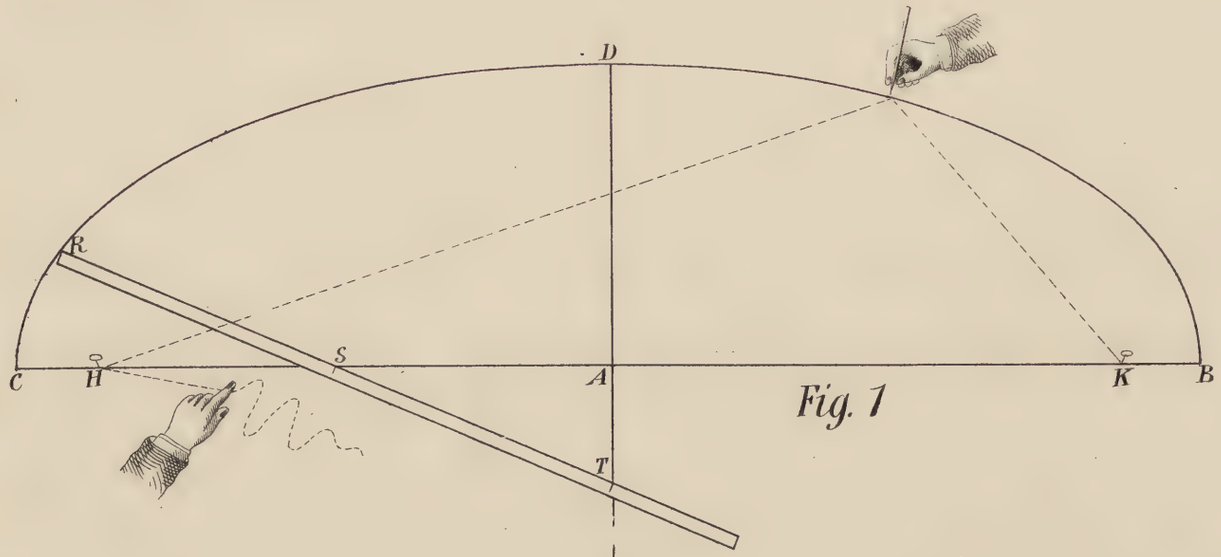


Fig. 1

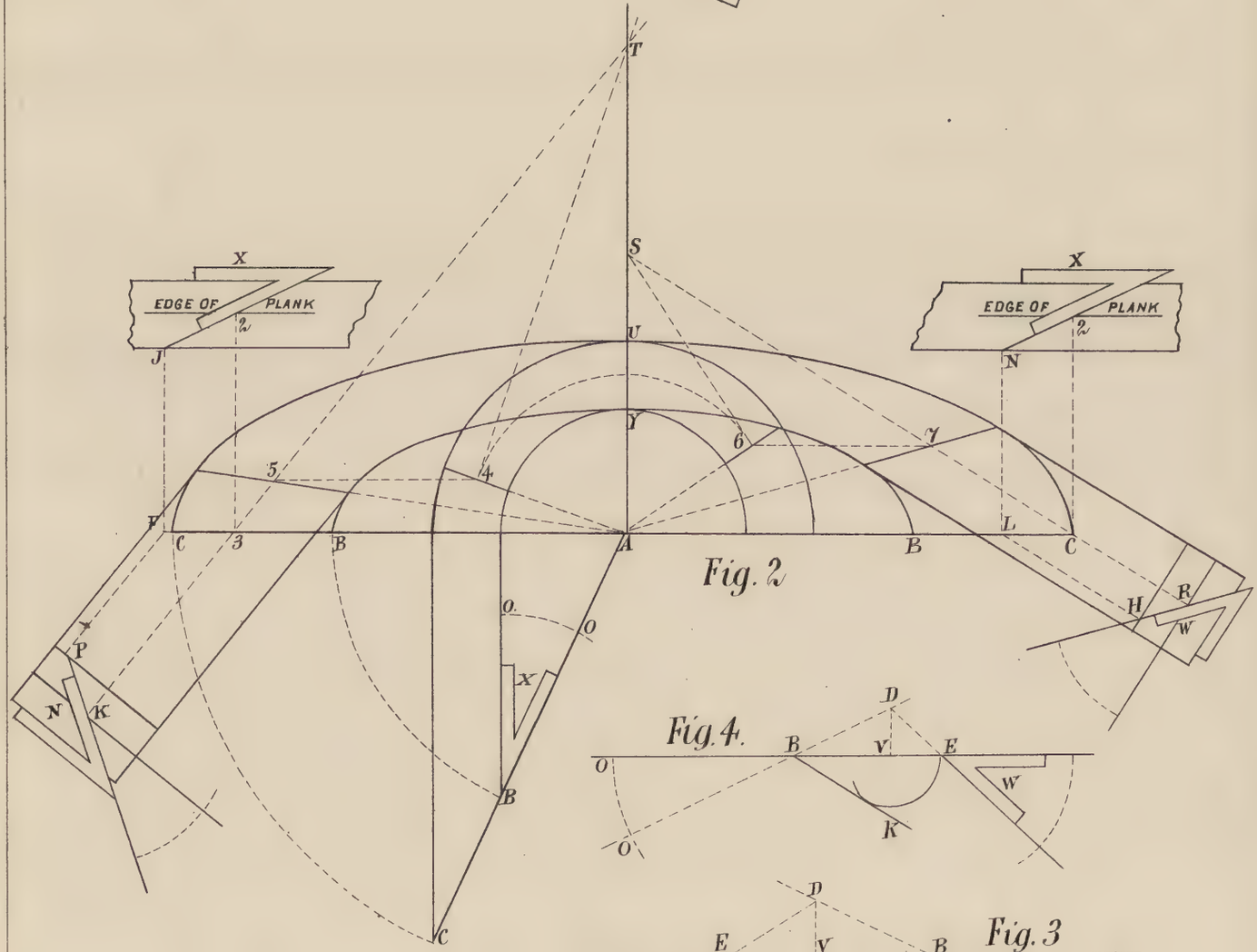


Fig. 2

Fig. 4.

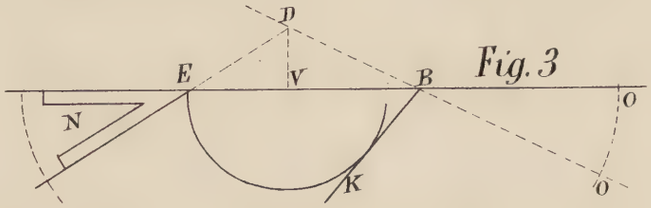


Fig. 3

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Plate 5

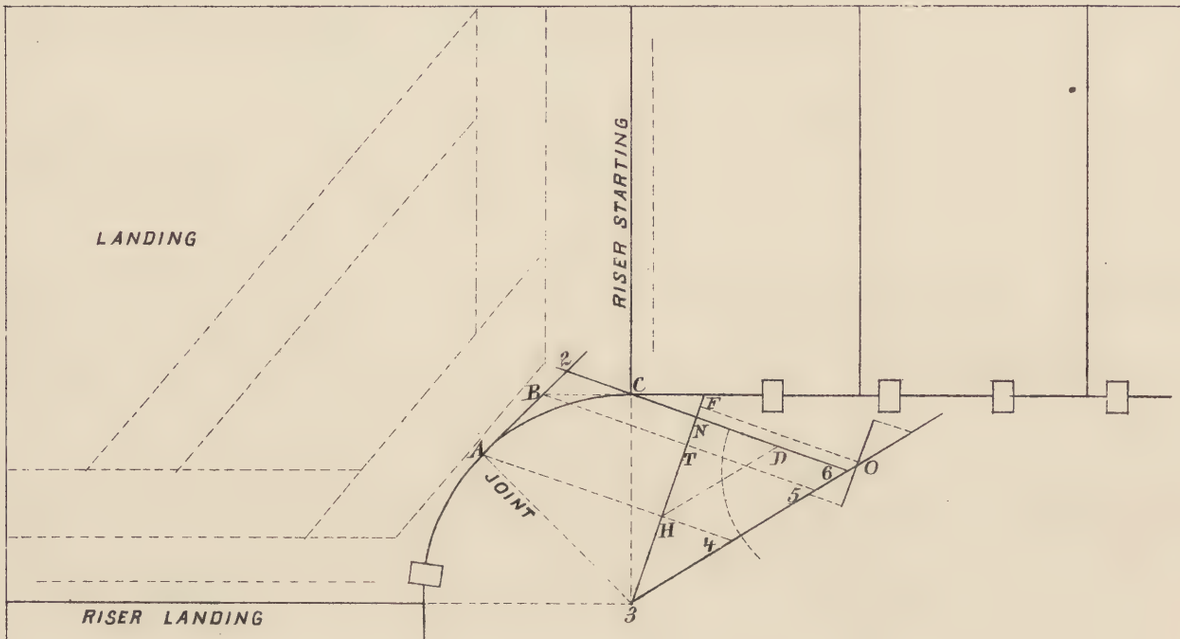

Fig. 1

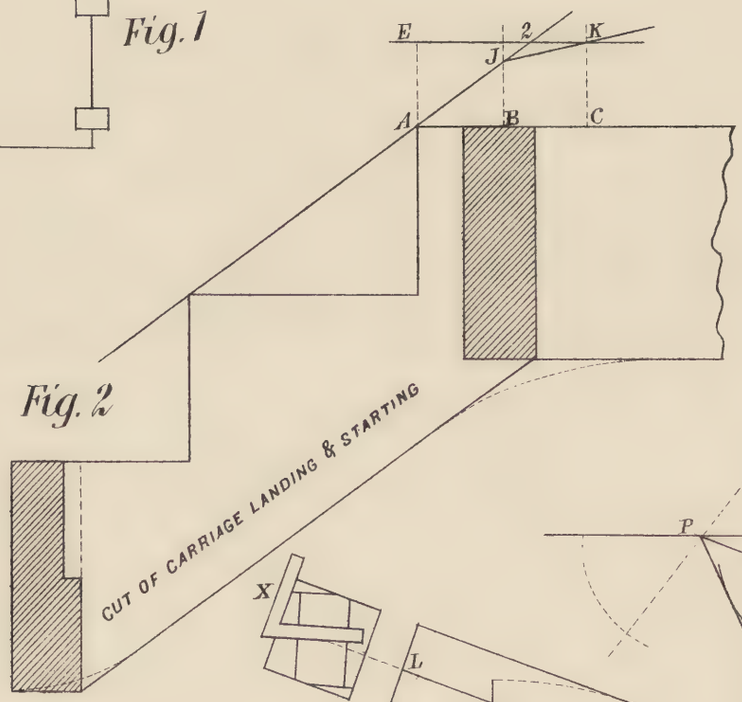

Fig. 2

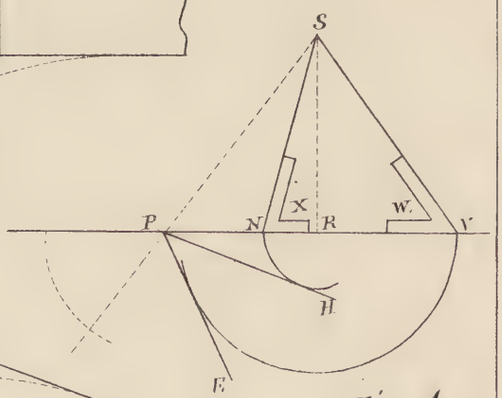

Fig. 4

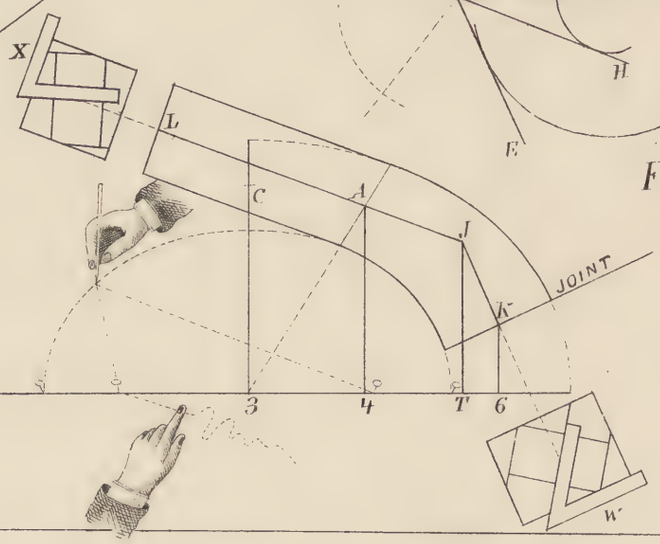

Fig. 3

Scale 1½ Inches

Plate 5.

QUARTER CIRCLE WREATH IN TWO PIECES.

Figure 1 shows ground-plan of stairs having a quarter circle and quarter landing. Here the face of the risers stand on the spring line, and the wreath will be in two pieces. This must always be the case when the arrangement of risers differs from that given in Plate 3. It is, however, better to have a wreath in two pieces than in one, as the grain of wood in the straight part can then run with the straight rail. In this form of wreath the practical value of joint bevels will be demonstrated.

Divide the quarter circle which represents the centre of rail in two equal parts by the point A. Draw the tangents through A B and B C; A B being at right angles with a line drawn from A to the centre 3, and B C a continuation of centre line of straight rail.

We must now make an elevation of square step, riser and part of the landing as shown at Fig. 2. Set off the points A B C to correspond with A B C in Fig. 1; draw a line as E K for half height of a riser above the landing and square up from A B C to cut this line. Now draw pitch of stairs, cutting through A and J and giving the distance E 2; transfer this to plan, making extended tangent A 2 equal it. Draw from 2 through C. This is the directing line for pitch of plank. Draw from A and B, parallel with 2 C, and from centre 3, square with 2 C. Make N D equal A E Fig. 2. Join D H. Draw from 3 parallel with D H. This line is pitch of plank, and always the major axis of a semi-ellipse; the half diameter of which is determined as follows: Make 3 F equal 3 C. Square up from F cutting the pitch at O, and through this point draw parallel with 3 N. Now determine width of rail and set off half of it on each side of O, cutting the pitch as shown.

To draw the mould, lay the edge of a board on the pitch and mark the points 3, 4, 5, 6; square these over as shown at Fig. 3. Make 4 A, T J and 6 K correspond with H A, T B and N C, Fig. 1. Draw from J through A and K. These are tangents, and to be correct must equal the pitches A, J, K, in Fig. 2. Draw the joint through K square with J K. Make 3 C equal radius 3 C on plan, and set off half the width of rail on each side of C. Now find points for pins and sweep the curves with a string. This done, draw from 3 through A, giving points for drawing straight wood parallel with J L. This completes the mould.

Fig. 4. To find bevels for joints: Draw any line as P V parallel with 3, 6, Fig. 3. From any point as P, draw P E and P H parallel with tangents J K and J A on mould; transfer pitch of plank from Fig. 1 as follows: From 6 as a centre and with any radius, draw the dotted arc. With same radius, and P centre, draw an arc of equal length, and from its lower corner draw the pitch through P; square over from any point as R cutting the pitch at S; from R as centre, and a radius touching P E, strike an arc cutting at V, join V S. This gives bevel W for centre joint of wreath. Again, take R as centre, and a radius touching P H, strike an arc cutting at N, join N S. This gives bevel X for joint on straight wood. The application of bevels to joints is shown by the square sections of plank.

Before commencing to work the wreath, see that your tools are in proper order, especially the square and bevels. Mark the plank full by the mould, and cut square through; face one side of each piece out of wind; lay on the mould; mark the joints and direction of tangents on the surface of stuff. The reason for this has been before explained. Both pieces being worked to the cylinder form, take them to a thickness by cutting the slabs on straight part to near the spring line. Complete the piece by taking off the slabs on circular part, which is easily done, as the square section of rail marked on centre joint gives a clear direction. It is best to leave the stuff full at all joints made in the circular part of a wreath, for the purpose of removing any defect that might appear when the joints are bolted together. Now clean off to width and thickness, and in putting together, be particular to keep the lines made by bevel W on each joint, exactly opposite. This throws the straight wood on each piece of wreath to their proper pitches.

Plate 6.

THE WREATH OVER SIX WINDERS. CYLINDER 15 INCHES.

Figure 1 shows the ground-plan of stairs, having winders and square steps. The semicircle shows centre line of rail. This may be divided into any number of winders, making their narrow ends equal to half a square step. The pitches of this wreath can be arranged so as to be equal. By this means the construction becomes quite simple, as a mould can be obtained from one of the pitches and the diagonal of a square, the sides of which are equal to the radius O P. This plan shows nine risers, but in making elevation omit one, because in going up the stairs from square step on the left, we make eight steps before arriving to the top of last riser on the right.

Fig. 2, on the right, shows the height of eight risers. The dotted perpendicular B B represents spring line, the arrows show position of risers standing beyond it, the same as on plan. Let the spaces R J and J B equal the radius O P on plan. Draw through J the dotted perpendicular A A, from 4 on the right square over a line, giving point B on the left. Now draw pitches through square steps. This shows that there must be a ramp above and below to connect with wreath by gentle curves. To form the ramp, draw a line from B on the left, cutting the lower pitch at P. Make the upper pitch equal. The whole height of wreath on spring line is shown as B B.

From these pitches, a mould for the wreath is readily obtained as follows. Form a square as shown; its sides being equal to the radius O P, Fig. 1. Draw from R parallel with diagonal line D C. Draw through C square with D C. Make height J 2 equal height J A on the left. Draw from C through 2. This line is pitch of plank, and on it we find half long diameter of semi-ellipse. This must always be given when the curves on a mould are to be struck by a string or trammel. Proceed by making C S equal C R. Square up from S, cutting the pitch at V. Through this point draw parallel with S C. Set off half width of rail on each side of V, cutting the pitch at points 2 and 3. This gives C 2 as half diameter for inside curve on mould and C 3 for outside curve.

Fig. 3. From the edge of a board square over any line as C A. Make C A equal the diagonal of square D C, Fig. 2. Take for radius any of the pitches on elevation, say A B, and from C and A as centres mark intersections on right and left, giving points B B, through which draw from A. These are tangents on the mould. Make the joints square with them. Draw from C through B on the right. Make C R equal O P on the plan. Set half width of rail on each side of R. Let C, 2, 3, equal corresponding letters on pitch at Fig. 2. Now find points for pins and sweep curves on mould with a string.

The pitches being equal, the same bevel will answer for each joint. To obtain this bevel, find pitch of plank as shown above the square. Take 2 for centre and with any radius draw dotted arc. With same radius return to Fig. 3 and take N for centre, draw dotted arc to equal the first and from its lower point E draw through N. From any point as H square up a line cutting at F. Take H for centre and strike an arc touching extended tangent A B and cutting at K. Join K F. This gives bevel X for joints on wreath. Its application is shown by the square sections.

Cut the stuff square through and work the wreath by the method already explained.

Plate 6

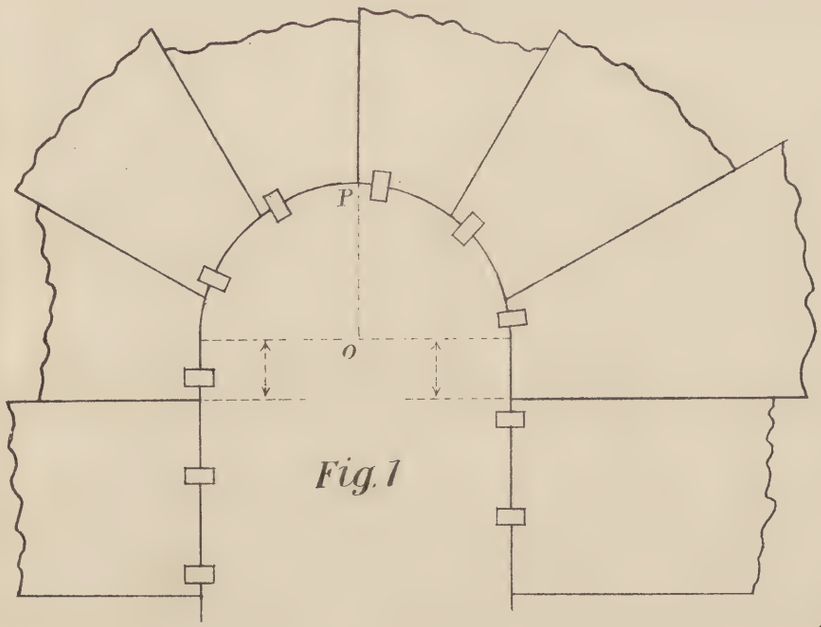

Fig. 1

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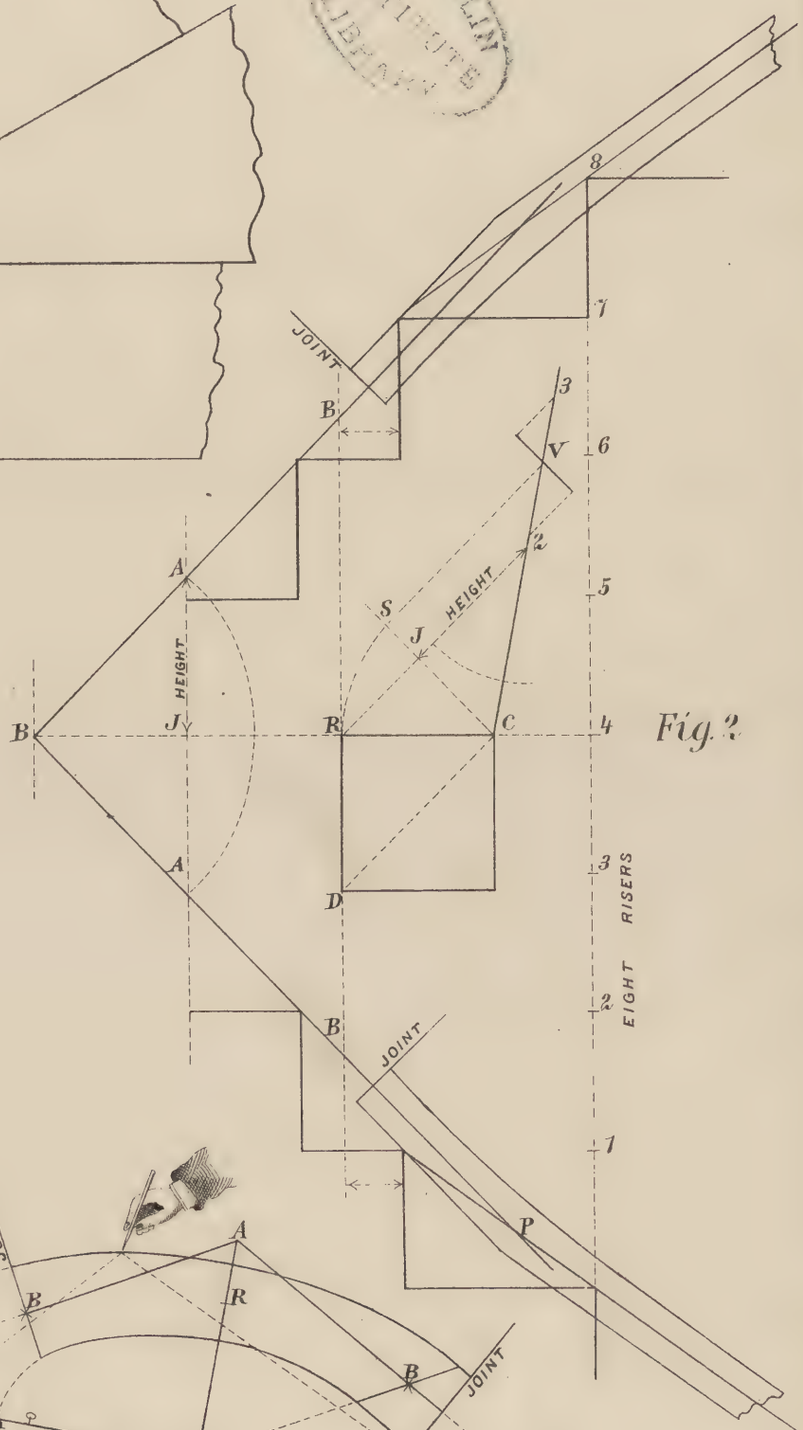

Fig. 2

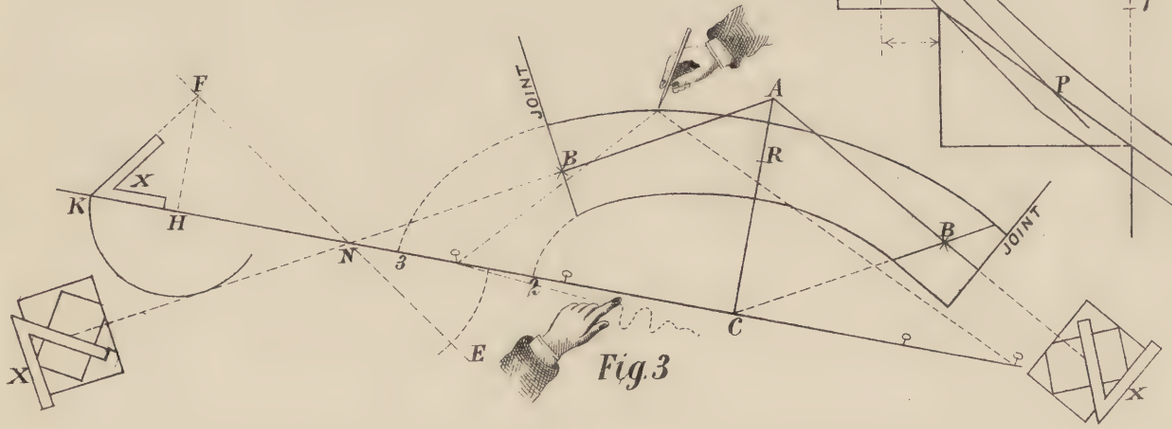

Fig. 3

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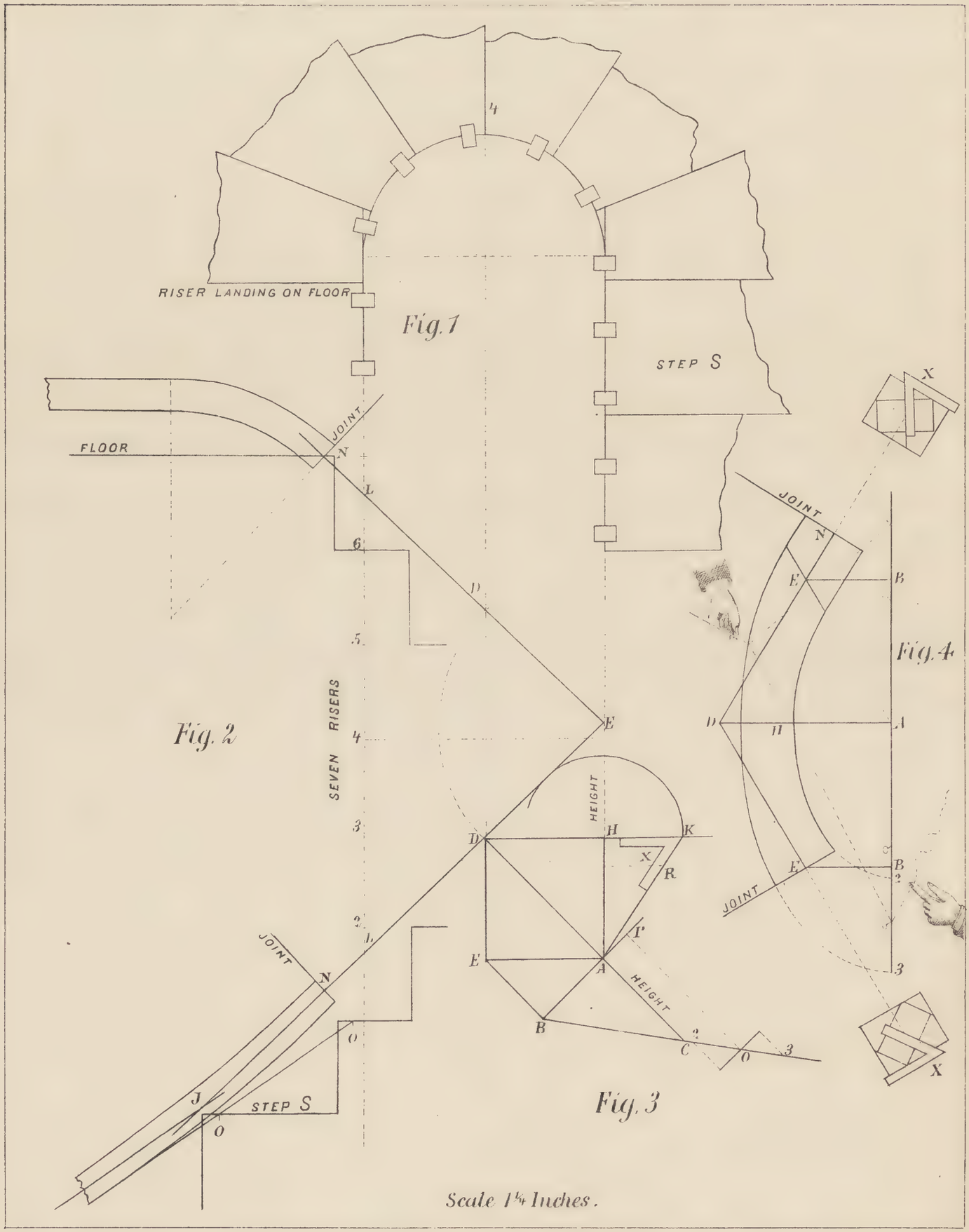
Plate 7



Scale 1¼ Inches.

Plate 7.

THE WREATH OVER SIX WINDERS LANDING ON A LEVEL FLOOR.

Figure 1. In order to show the certainty and practical application of this system of hand-railing to all forms of wreath, we have here given the ground-plan of stairs, where the riser landing is purposely placed in a most awkward position. In fact the whole arrangement is badly planned, and yet we shall find no difficulty in forming a wreath by the principles which are laid down.

Fig. 2 shows the elevation. Here we draw a square step and set off the number of risers above it, which in this case is seven. The square steps and two winders are shown below, and the floor line and two winders above, standing in the same position as those on the plan. The under side of rail at landing should stand half a riser above the floor line, and the under side of rail at step S should rest on the centre of short balusters O O. Draw half thickness of rake rail parallel with under side; square over the dotted line from 4, cutting perpendicular on the right; the point thus given represents position of riser 4 on plan. But in order to have easy ramps and at the same time make the rail a proper height at the landing, we must raise the wreath at its centre joint above riser 4, say to point E. To determine the lower ramp and pitch, assume any point in half thickness of rake rail as J; draw from J to E; this is lower pitch: make upper one equal to it as shown. The whole height of wreath is now given on spring line as L L.

To find the mould for wreath. From D square over a line cutting through H; form the square as shown, its sides being equal to radius of plan; draw a diagonal from D through A; draw from E parallel with D E; again draw through A square with D A; make height A C equal height H E; draw from B through C. This is pitch of plank and long diameter of semi-ellipse. To find half its diameter, make B P equal one side of the square; draw from P, cutting the pitch at O; draw through O parallel with B P; set half width of rail on each side of O, cutting the pitch at points 2 and 3. This gives B 2 as half long diameter for inside curve on mould, and B 3 for outside curve.

To find a bevel for joints. Take H for centre, and with a radius touching D E, strike an arc cutting at K, join K A and we have bevel X. This will apply to all the joints because the pitches of wreath are equal.

Fig. 4. Having obtained the points necessary, we will proceed to form the mould. Upon a piece of board, draw a line for the major axis. Set off on it from each side of A the distance B C Fig. 3, giving B B; square over these points; make A D and B E equal corresponding letters, Fig. 3; draw from D through E E. These are tangents, and to be correct must equal pitches on elevation. *Make A H equal radius on plan, and set off on each side of H, half width of rail; find points for pins and sweep the curves; mark the joints square with tangents. The square sections show the proper application of bevels. The straight wood E N of mould should equal N L on elevation where upper and lower joints of wreath connect with the ramps.

It may also be stated that from the bevel, half the width of mould across the joint is readily found, as follows: Set off half width of rail below H, Fig. 3; draw through this parallel with H K, cutting bevel at R. This gives K R as half the width of joints E N, Fig. 4. The importance of these small matters will be appreciated when we remember that the rail is to be jointed and finished on the bench ready for fixing.

*Note.—The radius of semi-circle on ground-plan will always give centre of mould on short diameter; as one of the properties of an ellipse is, that its minor axis never changes. This is made plain by the following simple experiment: When a tumbler half filled with water stands level on its bottom, the surface of the water presents a circle, its boundary the glass. Incline the tumbler to any angle, and the water immediately assumes the form of an ellipse, but still retains the diameter of the tumbler as its minor axis.

PLATE 8.

PLATFORM STAIRS.

FIGURE 1 shows a ground-plan for stairs, in which convenience, simplicity and safety are combined, and which should always be adopted where there is sufficient space. As before stated, the best result depends entirely upon the position of the risers in the cylinder; if these be placed right, the strings, wreaths, and everything throughout will present a finished and uniform appearance attainable in no other way. Hence the necessity of starting right and keeping the desired end in view from the very commencement. The first thing needed is the height of risers and width of step, accurately spaced off on a rod; the next a ground-plan to work by. The size of cylinder is determined by the length of step and space allowed for stairs. If this should be ample, the larger the cylinder the better. The semicircle in this Fig. shows centre line of rail, its diameter twelve inches. Two balusters stand on the platform, one of them opposite half diameter. Set off the balusters, making the spaces between their centres equal to half a square step. This at once determines the position of risers A and B. The same rule applies to cylinders varying from ten to fifteen inches. Proceed now to set off width of step on right and left, giving position of risers landing on, and starting from the platform. Observe that the face of riser starting should be curved. This may be worked solid, the thickness of riser being sufficient.

Fig. 2 shows the elevation. From this we obtain the joint bevels and the points to be used in forming the mould. In this case the height is three risers counting from A and including B; draw the elevation of two square steps and risers A and B, placing them in the same position from the spring line as on the plan, indicated by arrows in both places; draw upper and lower pitch through corners of square steps, cutting spring line and giving points E and F; divide the distance between these points equally as H; square over from H, cutting lower pitch at L; draw from E parallel with H L; form the square as shown, its sides are equal to radius of plan; square down from L, cutting at V. This is the directing point in finding pitch of plank. Now draw from V through U and parallel with this line, from K and E; draw through Y square with V U; make 6, 5 equal height E H on elevation; join 5, 2. This is pitch of plank and major axis. In order to show the points for forming the mould distinctly, the long diameter is raised above the pitch and parallel with it. Make Y R equal Y U; square up from R, cutting at O; draw through O parallel with R 2, and set off half width of rail on each side of O, giving 3, 8, and 3, 9, as half long diameter of elliptic curves on mould.

To find the bevels, take P for centre, and a radius touching E L; strike an arc cutting at N; join N H. This gives bevel W for joint on straight part of wreath. Now draw from H through T; and with K for centre, and a radius touching H T, strike an arc cutting at J; join J E. This gives bevel X for centre joint.

Lay the edge of a board on the pitch and mark points 2, 3, 4, 5; square these over as shown in Fig. 3; make 2 E, 4 T, and 5 H equal 2 E, Z K, and 6 U, Fig. 2; draw from T through E and H. These are tangents on mould, and to be correct must equal pitches E T H on elevation. Draw from 3 through E; find centre of mould O from radius, and set off half width of rail on each side of it; find points for pins and strike the curves; mark the joint H square with tangent. The termination of curves on line through E gives the width for straight part of mould. This may be obtained with more exactness from bevel W by the method already explained.

The stuff being cut, joints made, and bevels applied as shown, take off the slab on upper side, indicated by dotted line; work by bevel W and apply a square to this edge and across the joint; square a line from 2, continuing it along the beveled edge; set off on this the distance E F, and draw the spring line by the pitch board. This might be called the plumb line, as it really is when in position over the plan. When putting the wreath together, see that lines made by bevel X on the joint of each piece come exactly opposite.

Plate 8

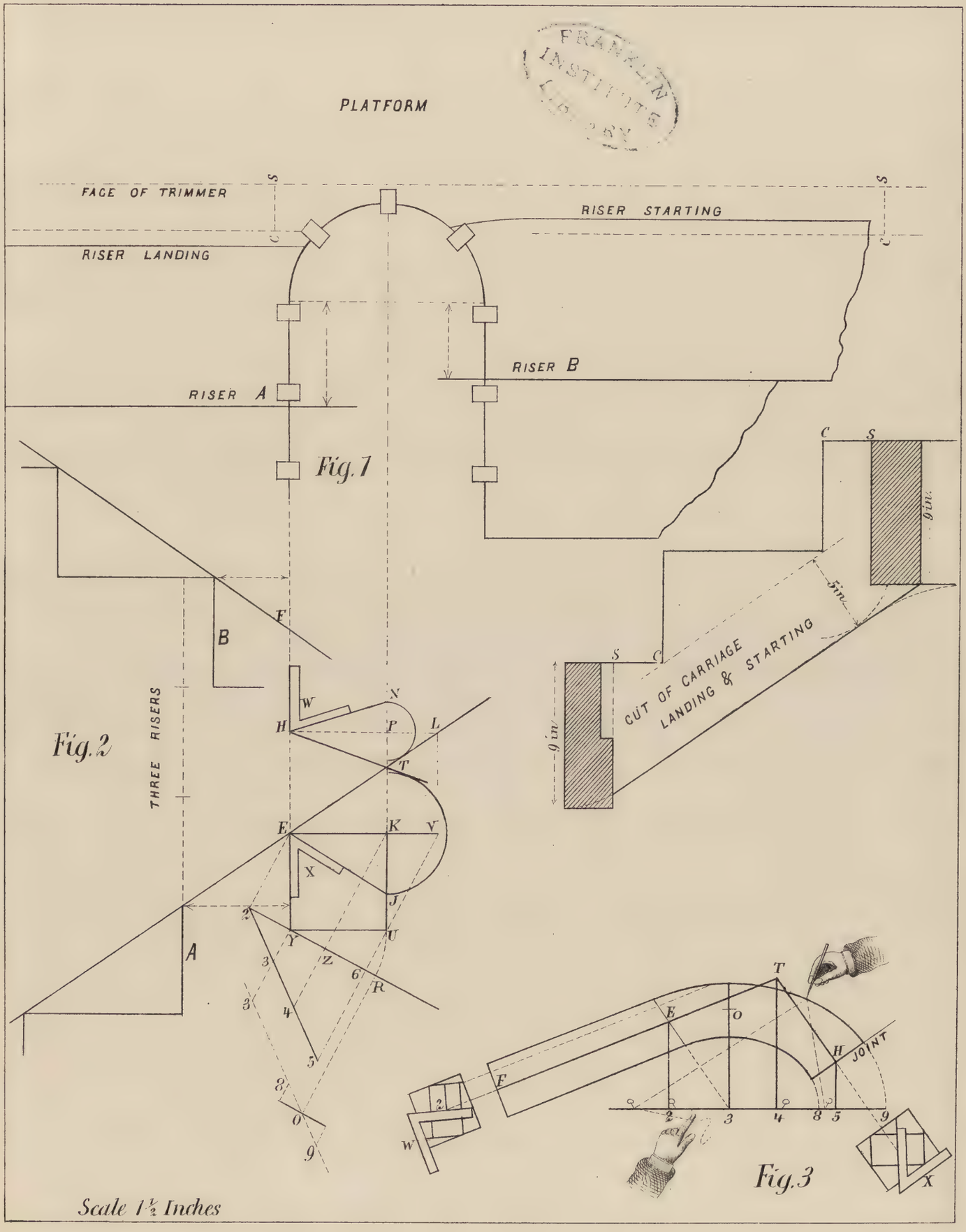

PLATFORM
FACE OF TRIMMER
RISER LANDING
RISER STARTING
RISER A
RISER B
Fig. 1
CUT OF CARRIAGE LANDING & STARTING
9 in.
5 in.
Fig. 2
THREE RISERS
Fig. 3
JOINT
Scale 1½ Inches

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Plate 9

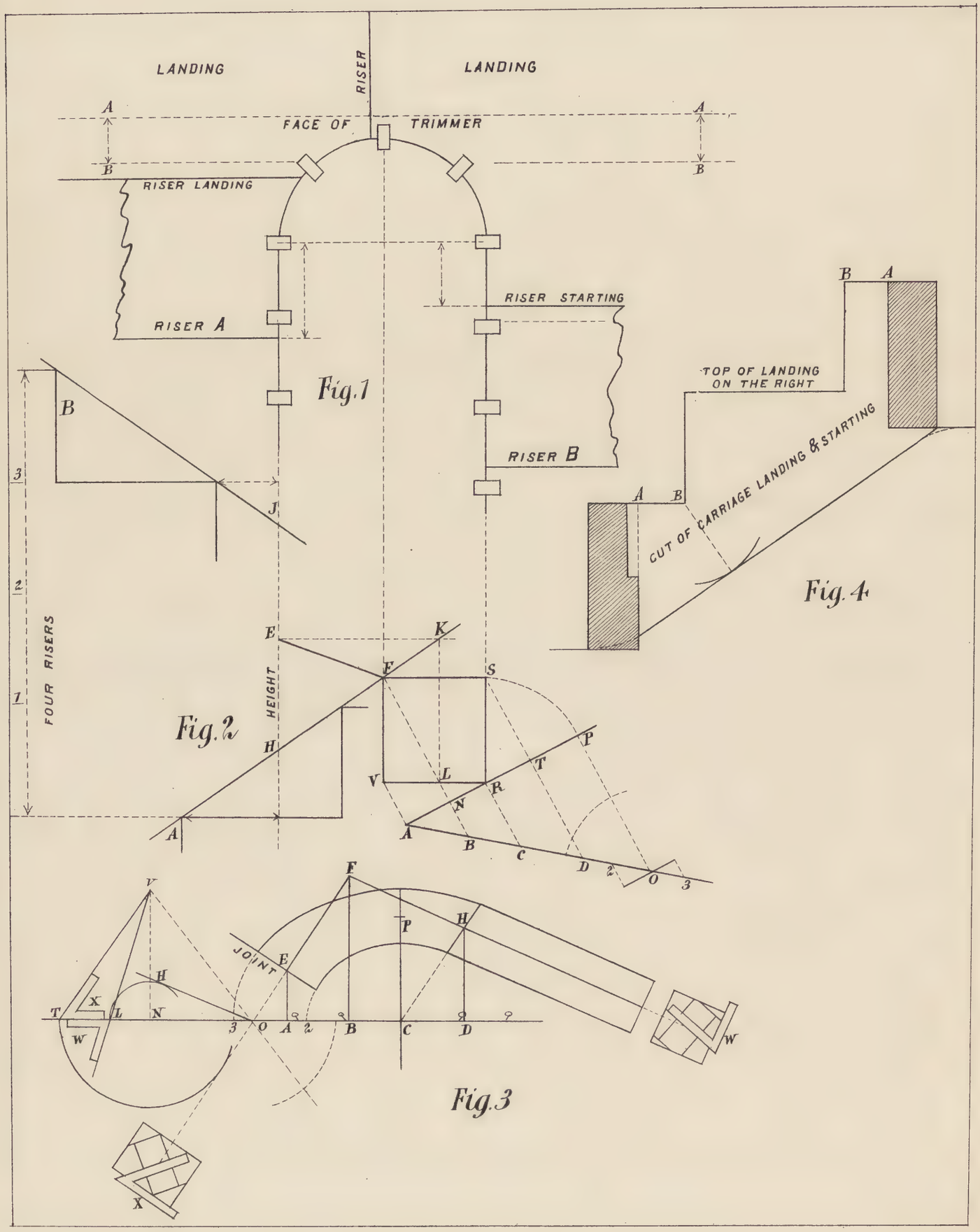
LANDING
RISER
LANDING
A
B
FACE OF TRIMMER
A
B
RISER LANDING
RISER A
RISER STARTING
RISER B
Fig. 1
B
3
2
1
FOUR RISERS
J
E
K
F
S
HEIGHT
H
A
V
L
R
T
P
N
A
B
C
D
2
O
3
Fig. 2
B
A
TOP OF LANDING ON THE RIGHT
A
B
CUT OF CARRIAGE LANDING & STARTING
Fig. 4
V
F
P
H
JOINT
E
H
T
X
L
N
W
3
O
A
2
B
C
D
W
Fig. 3
X

Plate 9.

PLATFORM STAIRS CONVERTED INTO TWO QUARTER LANDINGS.

It sometimes happens that, either through the carelessness or ignorance of a builder, stairs are put up and finished without regard to convenience or comfort. When this is the case, it is always desirable to make an improvement, and that this may sometimes be done without much trouble is shown in the accompanying plate.

Fig. 1 is the plan of stairs, supposed to be finished; with rail, balusters and everything complete. The platform is one step below the floor of a room, entered from it by a door on the right, which is very objectionable, for, in leaving the room, it is necessary to take one step down before ascending the next flight. This fault, however, may be easily remedied and without deranging anything, by simply throwing a riser across the landing, and raising one half of it to the height of the floor; converting it into two quarter platforms. The one on the right should be wider by a step than that on the left. This will throw riser starting beyond the spring line and make riser landing stand in the cylinder. A reference to the plan and cut of carriage will clearly explain this.

Any one conversant with the preceding plates would have no difficulty in constructing a wreath for this plan; but, in order to make clear one or two points that will assist in comprehending the plates that follow, a brief explanation is perhaps necessary. The number of risers, counting from riser A to riser B, is four.

Fig. 2 shows the elevation of two steps, and the height of four risers. The dotted perpendicular through E represents the spring line, and from it project risers A and B, the same as those on plan. Draw the upper pitch cutting at J, and the lower pitch cutting through H and F. This shows the whole height of wreath on spring-line as H J. From half this height, as E, square over a line cutting the lower pitch at K; join E F. Form the square F S R V, its sides to equal the radius on the plan. Square down from K, cutting at L; draw from F through L; draw from S V R parallels with F L; again, draw through R square with F L; make T D equal height H E; draw from A through D. This is pitch of plank. Find half the long diameter of a semi-ellipse, by making R P equal R S; square up from P, cutting the pitch in O, and through it, draw parallel with R P; set half width of rail on each side of O, giving the points, as C 2 for inside curve on mould, and C 3 for outside curve.

To find the mould. Lay the edge of a board on the pitch, and mark the points A, B, C, D; these square over, as shown at Fig. 3. Make A E, B F and D H equal A V, N F and T S, Fig. 2; draw from F through H and E. These are tangents on the mould, and to be correct, must equal the pitches H F E, Fig. 2. Make C P equal radius on plan; set half width of rail on each side of P, draw from C through H. Now find points for pins and strike the curves with a string; add any length of straight wood desired, parallel with F H; make the joint E square with E F. This completes the mould for both pieces of wreath.

To find joint bevels. The method here differs from that given before, and will apply to any wreath, no matter what angle the tangents make on the plan, while the previous method will only apply to where the tangents form a right angle. Here the tangent F E being extended fixes a point in O. Draw O H parallel with tangent F H; transfer pitch of plank from Fig. 2 by taking O for centre, and with any radius, draw the dotted arc. With same radius, and O, Fig. 3, as centre, draw an arc of equal length, and from its lower corner, draw the pitch through O; square over from any point, as N, cutting the pitch at V. With N as centre and a radius touching H O, strike an arc cutting at L; draw from V through L. This gives bevel W for joint on straight wood. With same centre and a radius touching extended tangent F E strike an arc cutting at T; join T V, and we have bevel X for centre joint E. The square sections of plank show the proper application of the bevel to joints. In putting the wreath together, remember to keep the line made by bevel X on each joint, directly opposite. This will cause the straight wood of both pieces to stand on their correct pitches.

Plate 10.

THE WREATH STARTING FROM A LEVEL FLOOR.

Figure 1 shows the ground plan of stairs where the riser landing comes within a few inches of the spring line of cylinder. When this is the case, the lower part of wreath must be thrown on a pitch to meet the ramp formed on rake rail at landing. The following explanation with the plate will show how this may be done. We first find from the plan the number of risers that will stand under the wreath and ramp. Counting from A and including B there are three. The position of those beyond the spring line are indicated by arrows.

Fig. 2 shows the elevation; and O P H represents the spring line; the steps and risers stand in the same position to it as on the plan. The face of riser landing on floor projects beyond the spring line as shown by an arrow. Let under side of rake rail, both above and below, rest on the centre of short balusters as shown. Set off half its thickness and draw the upper pitch, cutting through H and D. Now draw from D, say to E, or in such a manner as will make a ramp on rake rail at the landing. To form this ramp, square over from E, cutting perpendiculars at T and P. Make T U equal T D. Draw from E through U, cutting half thickness of rake rail at landing, and giving a direction to form the ramp. This line also shows that the lower piece of wreath will have equal pitches, and that O P will be its whole height on spring line. Then P H gives the height for upper piece of wreath. We have now the elevation of pitches and the form of ramp. The next thing will be a mould and the joint bevels for upper piece of wreath.

Fig. 3 shows the method of obtaining the bevels and the points for forming the mould. First draw a square, its sides equal to the radius of plan. Extend the upper line to the right and left. Make T R equal height P H on elevation. Square over from R, cutting at O. Make T V equal T V on elevation. Draw from V through corner of square E. Now draw parallel with this line from the other three corners of the square, as T S J. Draw through J square with V E. Make U N equal height T R and draw from L through N. This is pitch of plank and major axis. Make J H equal J E. Square up from H, cutting at O. Draw through O parallel with H L, and set off half width of rail on each side of O, cutting at 2, 3. This gives A 2 and A 3 as half diameters for curves on mould.

Before drawing the mould we will find the bevels. Draw from V to O. Make O F equal T C on the right. Draw from R through F. With S for centre and with a radius touching F R strike an arc, cutting at K. Join K J. This gives bevel X for centre joint. Then with T for centre and a radius touching V C, strike an arc cutting at 6. Draw from E through 6. This gives bevel W for joints on straight part of wreath.

In drawing the mould for upper piece of wreath lay the edge of a board on the pitch and mark the points N, A, B, L. Square them over as shown at Fig 4. Make N H, B D and L E equal U S, 4 T and L E, Fig. 3. Draw from D through H and E. These are tangents and must equal the pitches C O and F R, shown above the square in Fig 3. Find centre O from radius and set off on each side of it half the width of rail. Draw from A through H. Find points for pins and sweep the curves. Add straight wood from H and make the joints square with tangents. In working the piece, apply the bevels as shown by the square sections.

Fig. 5 shows how to draw the mould for lower piece of wreath. Form a square, its sides equal to the radius on plan. Draw the diagonal T U and parallel with it from K. Draw square with the diagonal through T, cutting at B. Make T D equal height T U on elevation. Draw from B through D. This line is pitch of plank. Make D B on the left equal D B on the right, and square over B D B. Make B O and B E equal B K, and D C equal T U. Draw from C through E and O. These are tangents and must equal pitches O U E on elevation. Make D N equal radius on plan and set off half width of rail on each side of N. The curves may now be struck with a string as before; or, in this case, with the compasses, because the pitches are flat. In other words, the wreath, when in position, will stand so nearly level that its form will vary but slightly from a true circle. The points, however, for elliptic curves are given as D, 5, 4. As the pitches for this wreath are equal, one bevel will answer for both joints. Take T for centre and with a radius touching pitch, strike an arc, cutting at P. Join P R, which gives bevel Z. Its application is shown on the square sections of plank.

Fig. 6 shows cut of carriage starting. This may be determined at once by the intersection which under side of joist make with lower edge of carriage, as the point S shows. Remember that this is a matter of some importance, if we consider that the whole weight of the stairs is supported by the carriage, and that this might be cut in such a manner as not only to weaken, but make the stairs absolutely dangerous; and leave a stain on the reputation of the workman, perhaps for years, and all for the want of a little consideration.

Plate 10

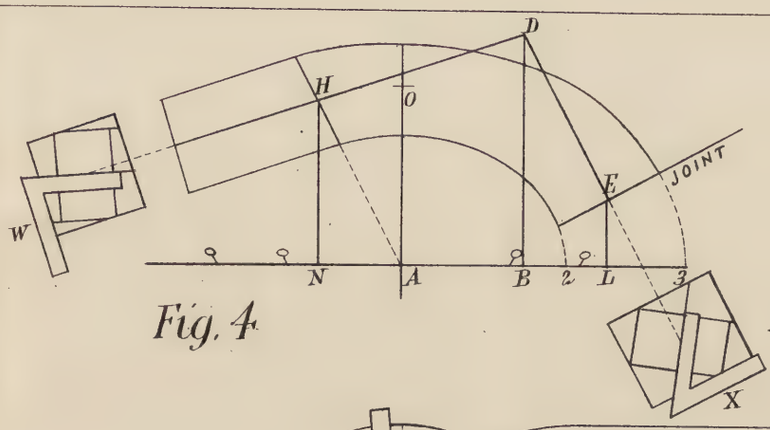

Fig. 4

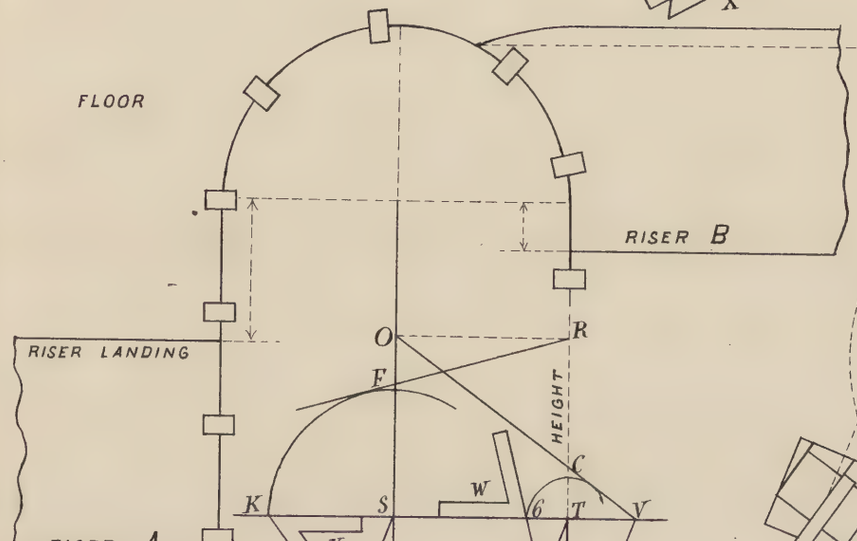

Fig. 3

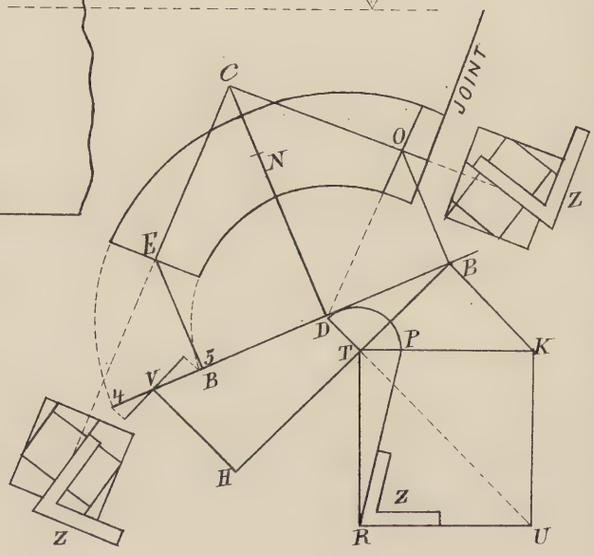

Fig. 5

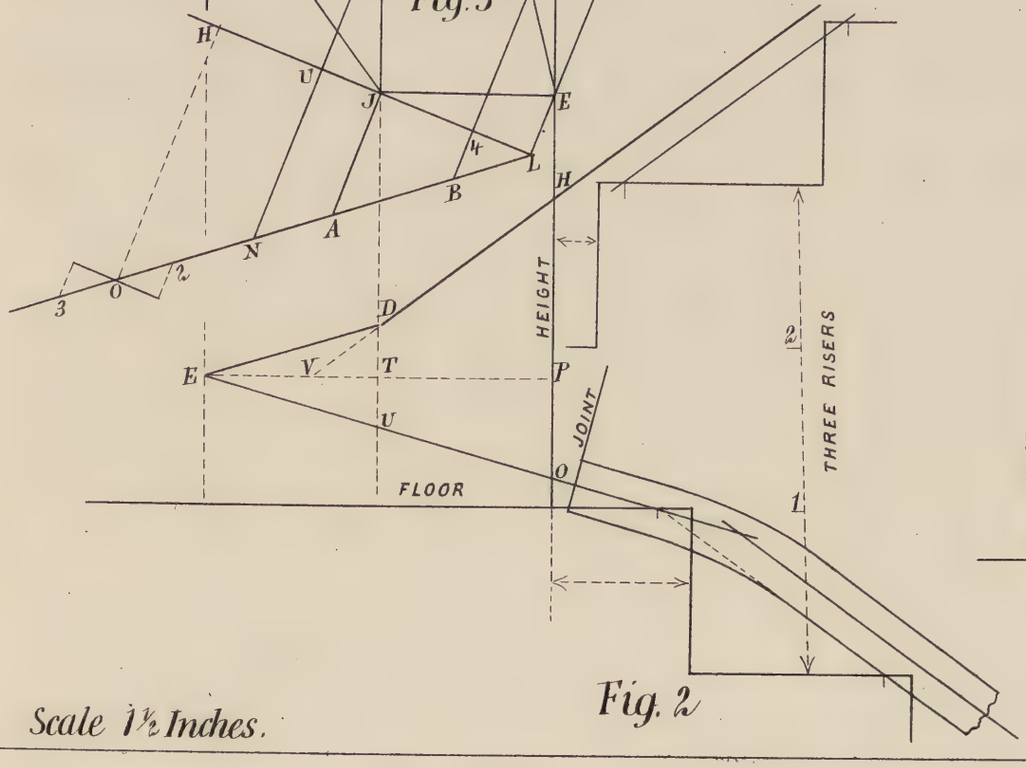

Fig. 2

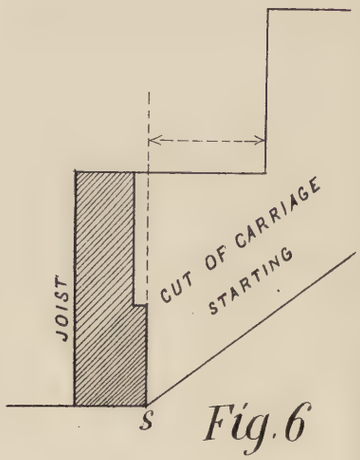

Fig. 6

Scale 1½ Inches.

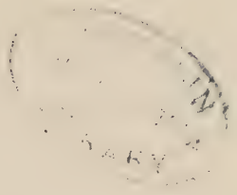

Plate 11

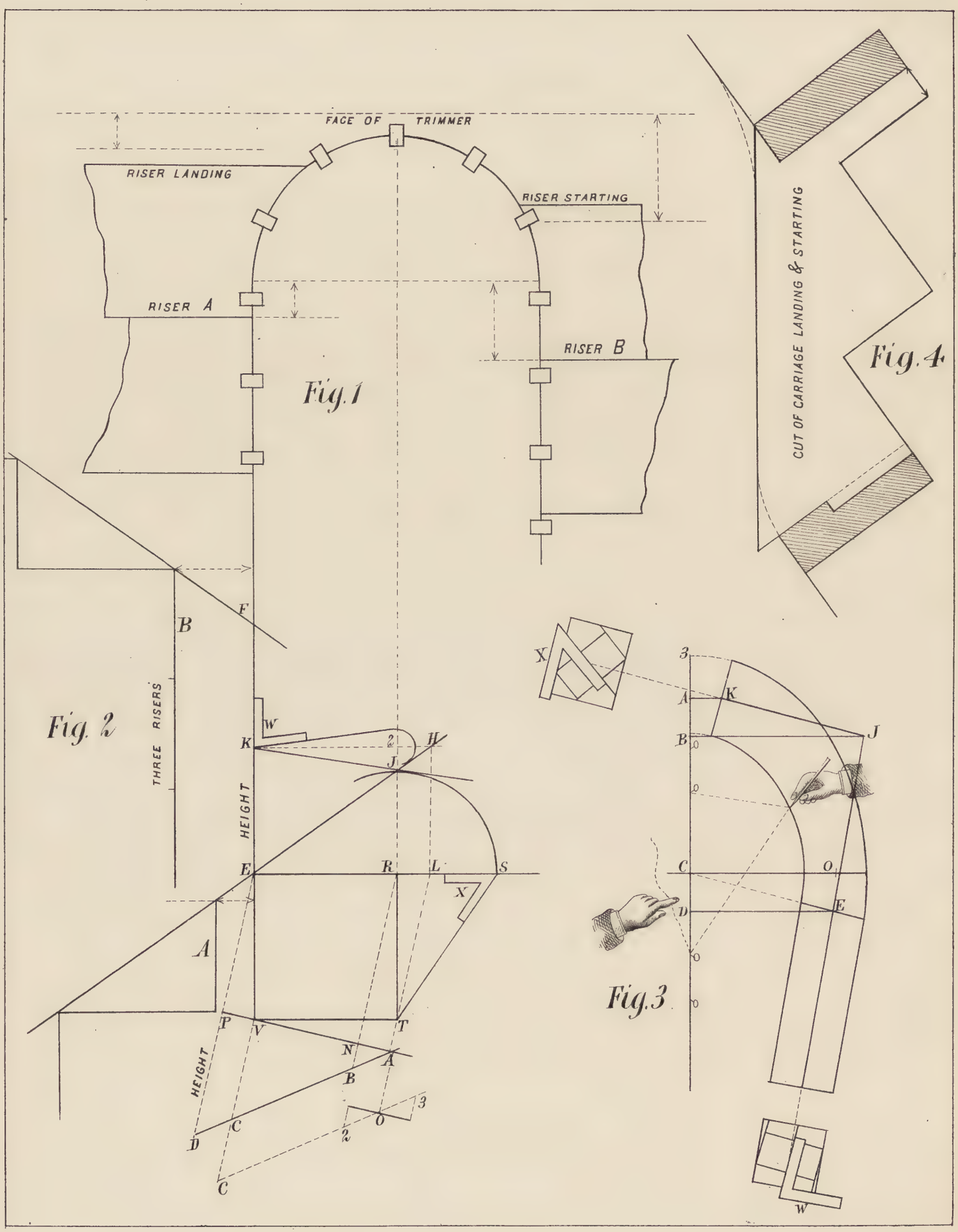
FACE OF TRIMMER
RISER LANDING
RISER STARTING
RISER A
RISER B
Fig. 1
CUT OF CARRIAGE LANDING & STARTING
Fig. 4
Fig. 2
THREE RISERS
HEIGHT
HEIGHT
Fig. 3

Plate 11.

PLATFORM-STAIRS. CYLINDER 17 INCHES.

Figure 1 shows the ground-plan. The semicircle represents the centre of rail. As the cylinder here is large, place three balusters on the platform. The method for forming the wreath and finding the bevels in this case will be the same as in the preceding plates. It is said that perfection can only be obtained by doing the same thing over and over again. If that be true, the repetition given in this work, in describing the plates, if closely followed, cannot fail to perfect the learner in a knowledge of everything connected with stair building.

Ascertain the number of rises necessary to make an elevation and proceed as usual.

Fig. 2 is the elevation showing the height of three risers. The perpendicular through E F represents spring line. Risers A and B and two square steps stand in the same position and project from it, the same as on the plan, shown by arrows in both places. Draw the pitches through corners of square steps above and below, cutting spring line at F and E. From half the distance between these points as K, square over dotted line, cutting pitch at H. Draw from E parallel with K H. Now form the square as shown, its sides equal to radius on plan. Extend the upper side to the right. Square down from H, cutting at L, and draw from L through corner of square at T. Draw from the other corners of the square parallel with L T. Draw through V square with L T. Make P D equal height E K. Join D A. This is pitch of plank. On the dotted line above and parallel with it are points C 2, 3, which are half long diameters for elliptic curves on mould. These are found in the same manner as in preceding cases. Next find bevels. Draw from K through J. Take R for centre and strike an arc touching line J K and cutting at S. Join S T. This gives bevel X for centre joint of wreath. Now take 2 for centre and strike an arc touching J H and cutting above 2. Draw from this point to K, which gives bevel W for joint on straight part of wreath. Now lay the edge of a board on the pitch and mark points A, B, C, D, square these over as shown Fig. 3. Make A K, B J and D E equal A T, N R and P E, Fig. 2. Draw from J, through E and K, giving the tangents. These must equal the pitches E, J, K, Fig. 2. Make C O equal radius on plan. Set half width of rail on each side of O. Draw from C through E. Now find points for pins and strike the curves. Make the joints square with tangents, and the mould is complete. The square sections on right and left show the application of bevels.

Note.—It must have been noticed by this time that the principles employed in the constructions already given are simple, and may be readily comprehended and applied by any one of ordinary intelligence. There is no secret or mystery about them which will not disappear after a few moments' intelligent study of any of the plates and their explanations. We start by fixing the position of a single point from which a line is drawn. This line determines the pitch of plank, or in other words shows its true position when standing over the cylinder. Upon the surface of this plank is shown two elliptic curves representing one-half the wreath. The drawings necessary for all this are simple and may be made by any one, without previous experience or expensive instruments, because the lines are principally right angles or parallels, and the points readily determined by fixed rules suggested by common sense; the tools that are requisite being a framing square and the compasses. If there be but the desire and ambition to learn, there is no problem in the whole range of hand railing but what may be readily solved by the principles laid down in this work.

PLATE 12.

PLATFORM-STAIRS. CYLINDER SIX INCHES.

FIGURE 1 shows a plan of stairs starting from a level floor. This plan should never be adopted in first-class buildings, as the short steps and small space between the STRINGS gives to the stairs a narrow and contracted appearance. The riser here stands on the spring line, and the wreath is of the most simple description. Its whole construction is given on the elevation of a square step. The plank is shown on pitch of stairs, its under side resting on centre of short balusters O O. The thickness of rail is gauged from under side, showing a slab on top, which is taken off in working. At the centre joint is given a square section of plank, and in this is drawn a section of rail, a glance at which will show how to take off the slabs; commence by taking off the under slab which forms the easing. The lower piece of wreath is shown on the right; its under side stands half a riser above the floor. This should be cut to the same thickness as the upper piece, and taken to the width of the rail. The wedge-shaped slab when taken off will bring the under side of both pieces at the joint on the same level. The remaining slabs on top side of straight part when cut off gives a plain direction to work the easing across both joints.

Fig. 2 shows the plan of platform-stairs having a six inch cylinder. The risers landing on and starting from the platform stand on the spring line. This makes the whole height of wreath over spring line equal to one riser, or half a riser for each piece of wreath. The method for forming the wreath is the same as given before; but in repeating here, we wish to direct particular attention to the subject of joint bevels.

Fig. 3 shows how to find the points for the mould and the joint bevels. Form a square, its sides equal to radius on plan; extend the upper side to right and left; set off on the perpendicular above J the height of half a riser, giving K; draw the pitch of the stairs from K by the pitchboard, cutting through T, and giving point R; from this draw through corner of square P; and from the other corners of the square draw parallel with R P; draw through E, square with R P; make F D equal height J K, and join D A. This is pitch of plank. The dotted line above it shows the major axis with points for half diameters of curves on mould.

To find the bevels, square over K N; make K L equal S T; draw from N through L; take J for centre, and strike an arc, touching L N, and cutting at U; join U E; this gives bevel X for centre joint; now take S for centre, and strike an arc, touching T R, and cutting at a point to the left of S; draw from P through this point, which gives bevel W for joints on straight part of wreath.

We are now ready to draw the mould. Lay the edge of a board on the pitch, and mark points A, B, C, D; square these over as shown at Fig. 4; make A T, C K, and D L equal A J, 2 S, and F P, Fig. 3; draw from K through T and L. These are tangents which must equal pitches T K and N L, shown above the square in Fig. 3. Complete the mould as before explained. The square sections of plank and rail show the application of the bevels.

Let us note here that the direction of joints across the width of rail is always at right angles with the tangents on its face, the bevels giving the cut through the thickness. These we have obtained from the pitches of wreath, finding the bevel for a joint through a given tangent, from the pitch which the tangent corresponds with. This method, however, will only apply when tangents on ground-plan form a right angle. But by the method which follows, and which we have already used in Plate 5, we can obtain correct bevels for any wreath, no matter what the angle formed, finding them directly from the tangents and pitch of plank. This method is therefore of universal application.

Fig. 5. Take any point upon a line parallel with the long diameter in Fig. 4, as 2; from this, draw 2 K and 2 L parallel with tangents K T and K L on mould; transfer pitch of plank from Fig. 3, as follows: Take D for centre, and with any radius draw dotted arc; then with same radius and with 2, Fig. 5, for centre, draw an arc of equal length, and from its lower point draw the pitch through 2; square up from any point on long diameter, as H, cutting the pitch at S; then with H for centre, strike an arc touching 2 K, and cutting at R; draw from S through R; this gives bevel W. Again take H for centre, and strike an arc touching 2 L and cutting at 3; join 3 S which gives bevel X. These bevels correspond exactly with bevels W and X in Fig. 3, clearly proving the practical value and reliability of this method.

Plate 12

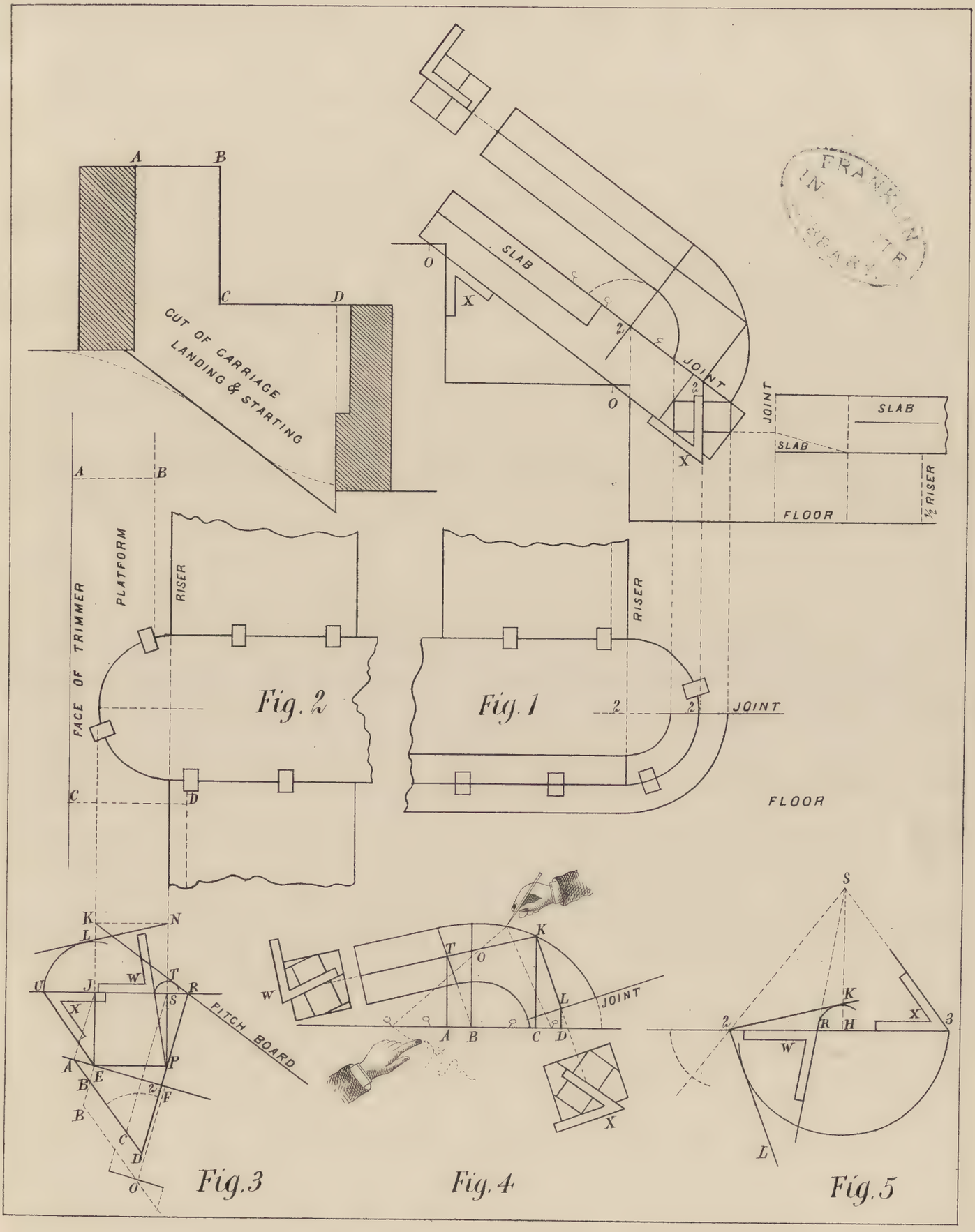

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Plate 13

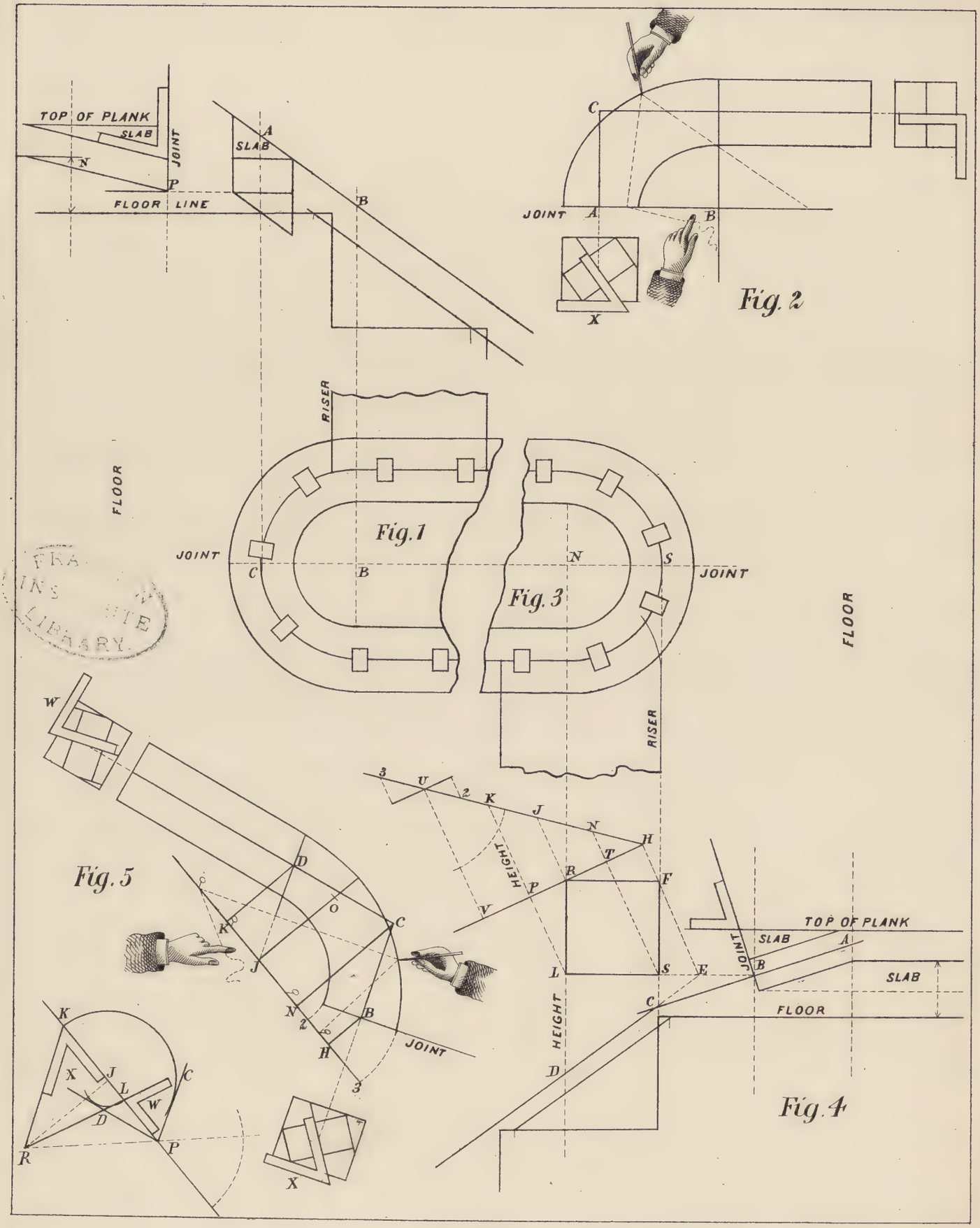

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PLATE 13.

WREATHS LANDING ON A LEVEL FLOOR.

THIS plate is intended to show the effect produced in a wreath by the wrong position of the risers, and the necessity for placing them properly in order to obtain the best results.

Fig. 1 shows plan and elevation of stairs, in which the riser landing stands to the left of the spring line, its position evidently fixed without any regard to height of level rail at the landing. This careless mode of proceeding always causes unnecessary work, besides making it impossible to construct a perfect wreath. The elevation above shows square step, and floor line. The under side of rake rail rests on centre of short balusters. The square section represents centre joint of lower piece of wreath. The under side of this *should* stand the height of half a riser above the floor line as indicated by the arrow on the left, but does not. This error is caused by the riser being in a wrong position. If the riser had been placed on the right of the spring line, it would have thrown the centre of wreath to its proper height. The only way to get over this difficulty is as follows: Make the level piece of wreath a parallel width the same as rail. Cut both pieces of wreath from a plank of the same thickness, and take slabs off top and bottom of upper piece as shown in elevation. This brings point P to meet under side of lower piece of wreath at centre joint, the slabs from top and bottom of which being cut off, the ramp is easily formed. This gives as good a wreath as can be formed over such badly arranged stairs.

Fig. 2 shows the mould for lower piece of wreath. The method for drawing similar moulds has been so often explained that it need not be repeated.

Fig 3 shows plan of similar stairs but with the riser in proper position. Here the face of riser stands on a line with centre of rail at point S.

Fig. 4 is the elevation of a square step and floor line. Set off from riser, on floor line, two spaces each equal to radius N S on plan and draw the dotted perpendiculars. Let under side of rake rail rest on centre of short balusters. Show half its thickness by a line through D C. Make under side of level rail stand half a riser above the floor as indicated by an arrow. Draw a line above this, showing its thickness and also top of plank. Cut both pieces of wreath from the same plank. Then by taking off the slabs from top and bottom of upper piece of wreath as shown, part of the ramp is formed. Draw the line A B C and from centre of joint B, draw to the left parallel with floor, and cutting perpendiculars at S and L. This gives D L as the height for lower piece of wreath.

To find the points for drawing the mould. Form a square as usual. Extend the pitch D C, cutting at E; draw from E through F, and parallel with this line draw from the other corners of the square. Again draw through R, square with E F, cutting at H; make height P K equal height D L; draw from H through K. This is pitch of plank. Find half long diameter of semi-ellipse, by making R V equal R L; square up from V, cutting at U; draw through it parallel with V P; set half width of rail on each side of U. This gives J 2 for inside curve on mould, and J 3 for outside curve.

Now lay the edge of a board on the pitch, and mark the points H, N, J, K; square these over as shown at Fig. 5; make K D, N C, and H B equal corresponding distances on the right, as P L, T S, and H F; draw from C through D and B. These are tangents on the mould, and to be correct must equal pitches D B C, Fig. 4.

Make J O equal radius on plan. Set half the width of rail on each side of O; draw from J through D. Now find points for pins and strike the curves; mark joints square with tangents and add straight wood from D. This completes mould for lower piece of wreath. The upper piece is shown on plan, its curves are two quarter-circles struck from centre N, and its width the same as rail.

Find the bevels from the tangents and pitch of plank as follows: Upon any line parallel with the long diameter fix upon a point as P. From this draw P C and P D, parallel with the tangents on mould. Now transfer pitch of plank from Fig. 4, as follows: Take U for centre, and with any radius draw dotted arc; with same radius, and with P for centre draw an arc of equal length; from its upper point draw the pitch through P; square up from any point, as J, cutting pitch at R; with J for centre strike an arc touching P C, and cutting at K; join K R, which gives bevel X for centre joint. From the same centre strike an arc touching P D and cutting at L; draw from R through L, which gives bevel W for joint on straight part of wreath.

NOTE.—In cutting the plank for level piece of wreath, allow enough wood to make centre joint B. The direction of joint on surface of plank will be parallel with line N S on plan.

Plate 14.

THE WREATH STARTING FROM A LEVEL FLOOR.

Figure 1 shows plan of stairs in which the riser starting is purposely placed in a wrong position, in order to show how errors and mistakes may sometimes be remedied by simple means. We wish to impress upon the learner, however, that there will be more satisfaction in starting right, and working by correct principles throughout, than in correcting errors and covering mistakes by means however ingenious. As in the last plate, we are here required to form a perfect wreath over a defective plan. The face of the riser should have projected past the spring line a distance equal to the radius, or, if still further, the difficulty of forming the easing which the wreath should have from level to rake would be lessened. It is a fault common to many wreaths, starting from a level floor, that the lower corner along the concave side presents a broken or defective curve. In trying to correct this, some throw the section of rail at the joint out of square, but if the riser be placed aright on the start, there will be no trouble in giving to the wreath a uniform and graceful curve.

On account of the position of this riser, it will be necessary to change the joint from what is usual in order to give the wreath a regular height, when in position, over floor and steps. We will assume for it the line through E. This gives E F and F H as tangents for upper part of wreath.

Fig. 2 shows elevation of square step and floor line. The dotted perpendiculars passing through points H F E show tangents on plan unfolded. Let under side of lower wreath piece stand half a riser above the floor. The thickness of plank will be sufficient to form the easing on top and across the joint; let under side of rake rail rest on centre of short balusters; draw half its thickness through H and F; assume E as half the thickness of rail on lower piece of wreath; draw from F through E; make joint square with F E. It will now be seen that by cutting a slab from the top and bottom of the plank, an easing may be formed across the joint. Square over a line from E cutting at N, this gives N H as height for upper piece of wreath; extend the tangent E F on plan and make E P equal N P on elevation; draw from P through H; draw from F and E parallel with P H; draw through centre T square with P H; make L D equal height N H on elevation; join D A, this is pitch of plank. For convenience, we will find the half diameters on the dotted line parallel with this. Make T S equal T H; square up from S, cutting at O; draw through O parallel with T S; set half width of rail on each side of O, cutting at 2 and 3, and giving B 2 and B 3 as half diameter for the curves.

Lay the edge of a board on the pitch and mark the points A, B, C, D; square these over as shown at Fig. 3; make A H, C F, and D E, equal A E, R F, and L H, Fig. 1; draw from F through E and H. These are tangents and must equal pitches on elevation as E F H. Make B O equal radius on plan; draw from B through H; set off half width of rail on each side of O; find points for pins and sweep the curves; add straight wood from H, and make joints square with tangents. This completes the mould for upper piece of wreath.

Fig. 4. To find the joint bevels. Take any point as F on long diameter, and draw lines F H and F E parallel with tangents on the mould; transfer pitch of plank from Fig. 1 by taking D for centre, and with any radius, draw dotted arc; with same radius, and F Fig. 4 as centre, draw an arc of equal length, and from its lower corner draw the pitch through F; from any point as C, square up a line cutting the pitch in K; with C for centre, strike an arc touching F E, and cutting at 3; join 3 K. This gives bevel X for joint E. From same centre, strike an arc touching F H, and cutting at 2; draw from K through 2. This gives bevel W for joint on straight wood.

Fig. 5 shows cut of carriage starting. J is face of riser as shown on the plan. The joist stands to the left of the cylinder. It will be at once seen from this Fig., that if the carriage be cut to the right of L, its width through the cut will be less than the depth of joist, and if cut to the left, its width will be greater and therefore project below the ceiling. The method of ascertaining the proper cut will present itself readily to any practical mind, as well as the importance of paying proper attention to these details. We have before stated that as the carriage sustains the entire weight of the stairs, it is all important to have it properly fitted and well secured.

Plate 14

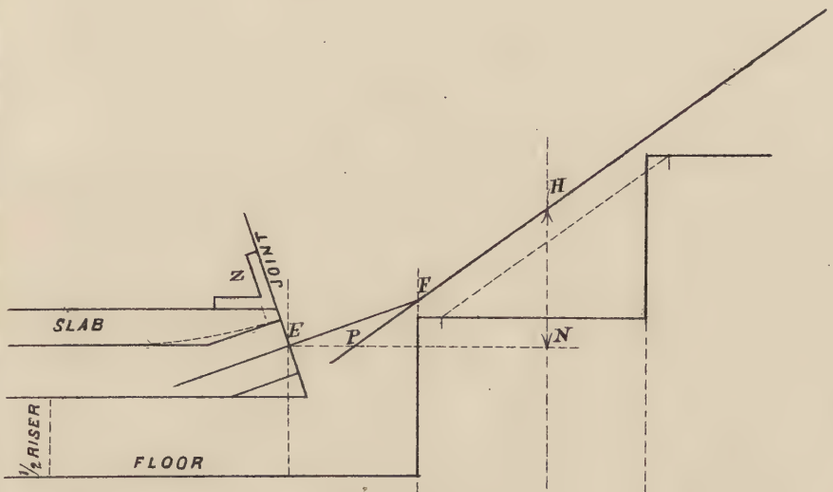

Fig. 2

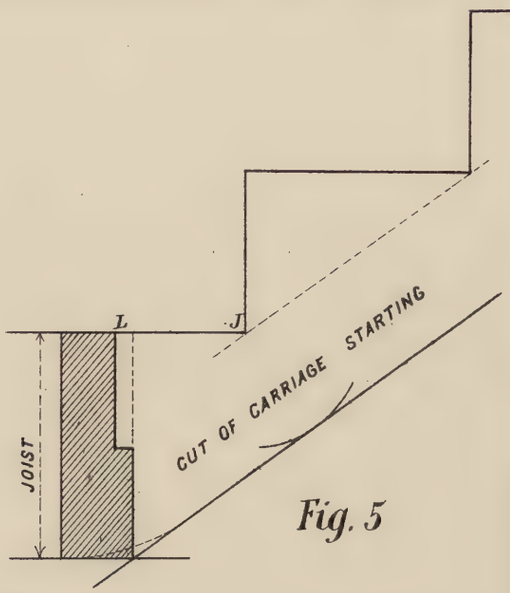

Fig. 5

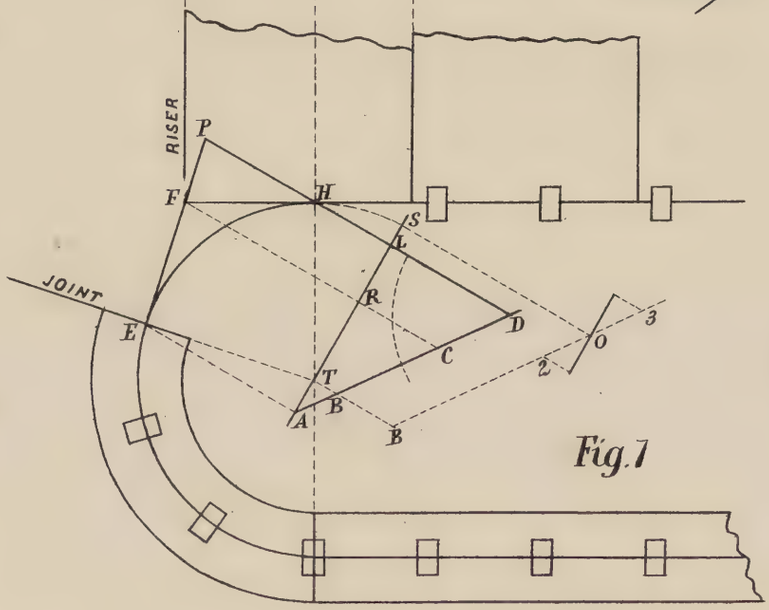

Fig. 1

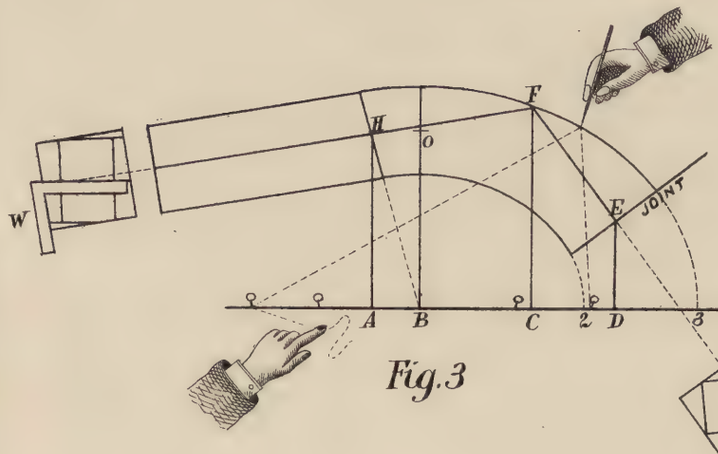

Fig. 3

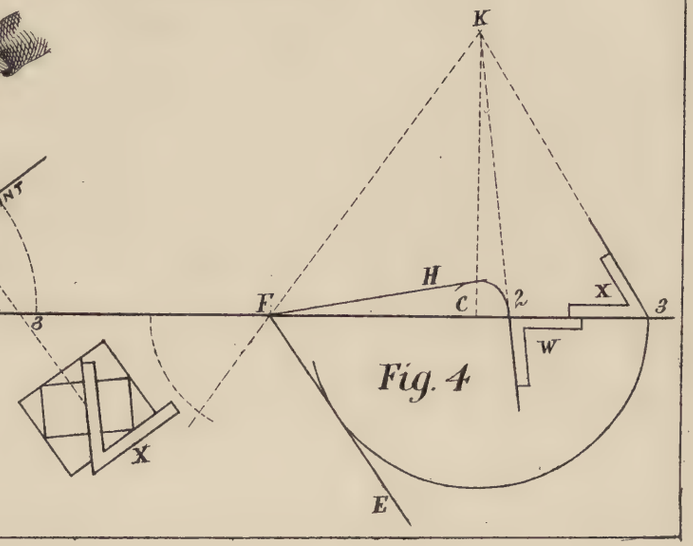

Fig. 4

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Plate 15

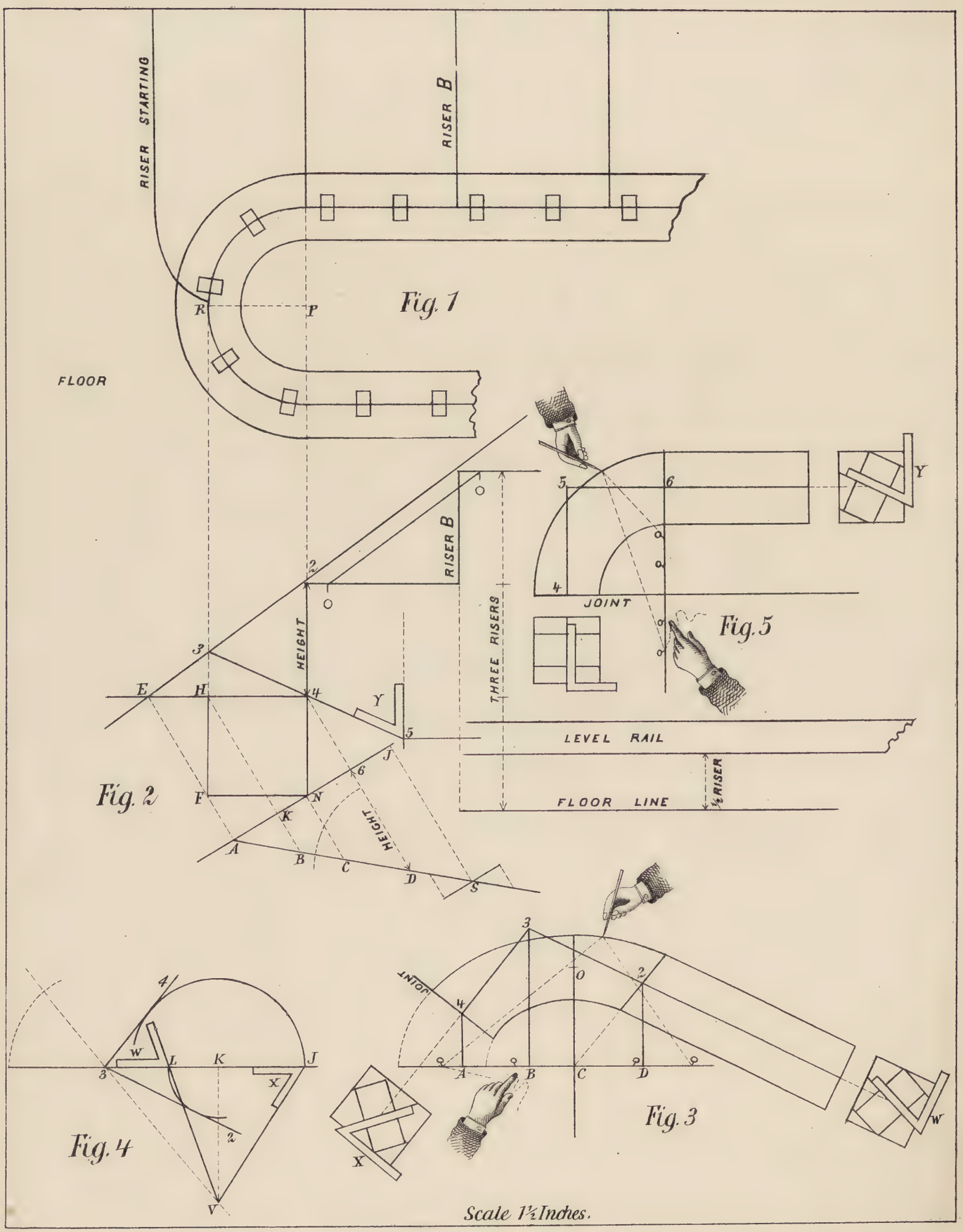
RISER STARTING
RISER B
R
P
Fig. 1
FLOOR
RISER B
HEIGHT
THREE RISERS
JOINT
Y
LEVEL RAIL
½ RISER
FLOOR LINE
Fig. 5
Fig. 2
HEIGHT
Fig. 4
JOINT
Fig. 3
Scale 1½ Inches.

Plate 15.

THE WREATH STARTING FROM A FLOOR OR PASSAGE WHERE THERE IS NO CYLINDER.

Figure 1. There are many examples of wood, metal, and stone stairs which have no cylinders, and yet have regular wreaths. In such cases, the lower part of wreath cannot be worked in the manner given before. We here give a plan of stairs starting from a passage without a cylinder, and in which the rail is required to continue along the passage.

Assume P R as radius for centre line of rail. We shall find by making an elevation of the pitches of wreath, that instead of cutting a slab from top and bottom of lower piece, as in the preceding example, it will be necessary to bevel the edge of straight wood in order to throw the centre joint to its proper height.

Fig. 2 shows the elevation of risers, floor line and one square step. By referring to the plan, we find the height of three risers necessary in obtaining the pitches, counting from the floor and including riser B. Set off to the right of spring line a distance equal to radius P R and draw the dotted perpendicular. Draw half thickness of level rail, cutting at 5. Let under side of rake rail rest on centre of short balusters. Set off half its thickness, cutting through 2 and 3. Join 3, 5. This gives 2, 3, 4, as pitches for upper, and 4, 5, for lower pieces of wreath.

The points for drawing the mould for upper piece are obtained as follows: Draw a line to the left of 4 and parallel with floor, cutting through H and E. Form the square and draw from E through its lower corner F. From the other corners of the square draw parallels with E F. Draw through N square with E F. Make height 6 D equal height 4, 2. Draw from A through D. This is pitch of plank. Now make N J equal N 4. Square up from J, cutting at S. Draw through S parallel with J A. Set off half width of rail on each side of S, giving the half diameters for curves on the mould, C being the centre.

Lay the edge of a board on the pitch and mark points A, B, C, D. Square these over as shown at Fig. 3. Make A 4, B 3, and D 2, equal A F, K H, and 6, 4, Fig. 2. Draw from 3 through 2 and 4. These are tangents, and must equal pitches 2, 3, 4, on elevation. Make C O equal radius on plan, set half width of rail on each side of O. Draw from C through 2. Find points for pins and sweep the curves. Make the joints square with the tangents. This completes mould for upper piece of wreath.

Fig. 4. To find the bevels. From any point on a line parallel with long diameter, as 3, draw lines 3, 2, and 3, 4, parallel with tangents on mould. Transfer pitch of plank from Fig. 2, as follows: With D for centre and any radius draw dotted arc, and with same radius and 3 Fig. 4 for centre, draw an arc of equal length, and from its upper point draw the pitch through 3. Square down a line from any point as K, cutting the pitch at V. With K for centre, strike an arc touching 3, 4, and cutting at J. Join J V. This gives bevel X for centre joint. From same centre strike an arc touching 3, 2, cutting at L. Draw from V through L. This gives bevel W for joint on straight wood of wreath. The sections on right and left show the application of bevels.

Fig. 5 shows the mould for lower piece of wreath, which is quite simple. Upon a piece of board square over two lines, shown as perpendiculars through 5 and 6, the distance between them equal to radius on plan. Make 4, 5, equal pitch 4, 5, on elevation. Draw from 5 parallel with edge of board, cutting through 6. Set off half width of rail on each side of 4. The joint through 4 is on the short diameter of semi-ellipse and the line through 6 is long diameter. Find half width of mould from bevel Y on elevation and set it off on each side of 6; the method has already been explained. Find points for pins and strike the curves. Add straight wood from 6. The section of plank and rail on the right shows how to apply bevel Y, and the section opposite 4 shows the centre joint, having equal slabs cut off both sides.

When the stairs are of stone or metal and are to have metal balusters, capped by a wood rail, work the wreath to its proper form, fit and bolt the joints together, and before moulding, rabbet the under side for the iron strap that connects the top of the balusters. Then let the smith fit this strap or flange to your work. This is far preferable to the haphazard way of fitting after the smith.

Plate 16.

SIDE WREATH STARTING FROM A NEWEL.

This simple problem has often perplexed the beginner, and sometimes the more experienced stair builder, when they have had no guide in determining the height for newel and its projection from string.

This plate shows for the first time, and by entirely new diagrams, how to form the wreath, no matter what the height, position, or projection of the newel. Or in other words, it gives plain directions for connecting the rail with the mitre cap by any desired curve. The first to be considered on the ground-plan is the side curve or projection, to the width of passage. If there be room, make the projection as much as possible so as to extend the curve, which will give a much better effect to the stairs.

Fig. 1 shows elevation of square step and riser. Let under side of rake rail rest on centre of short balusters O O. Set off half its thickness, as shown. Fix upon the height of newel, from the top of step to under side of cap, say it shall equal the height of a long baluster; which is half a riser more than a short one, when there are two on a step. Set off half a riser above the step as indicated by an arrow, and from this draw half thickness of rail, cutting pitch at D. This is a fixed point; and through it draw the dotted perpendicular. We are now ready to lay down a correct ground-plan. Draw any line parallel with step, as that through A B; cutting perpendicular through D, and fixing point A. Decide upon centre of newel, giving it any desired projection from A B, and on a line with face of riser. Assume C as the point. Draw from C through A. With C for centre draw size of cap. Cut off a portion equal to width of rail, by a line through 2, square with A C, and draw the two parallel curves showing width of rail. These curves may be extended to any point on the left as B. This completes the ground-plan.

To find the mould we proceed as follows: Square up from B, or the termination of curves, cutting the pitch at E. Square over from E, cutting at F. This gives D F for height of wreath. Draw any number of lines through width of rail, parallel with A C. Extend line A C and fix a point on it as J. Square over from J, cutting through D. Make D E equal height D F, Fig. 1. Draw from E through J; this is pitch of plank. Now draw from all the points cutting pitch, square with E J. Make J D 2 equal J A 2, and E F equal D B; draw from D through F. This is tangent on the mould, and to be correct must equal pitch D E, Fig. 1. Find points, through which trace the curves on mould. Leave the lower end of the mould square; making length of mitre from 2 the same as on the plan.

We next find the bevels as follows: From any point as A on the right, draw A J parallel with A J on the left; and A F parallel with tangent D F on mould. From any point as K, square down, cutting at J. Take K for centre, and with a radius touching A F, strike an arc, cutting at N; join J N; this gives bevel W for joint on upper end of wreath. The line A J gives bevel X, which is to be applied to square edge of plank. The line made by it will stand plumb when the rail is in position, and fixes the points by which to apply the mould. After the stuff is cut square through and joints made, the mould is to be applied to both sides of the piece; keeping the mitre point on the mould exactly over the points on top and bottom made by bevel X across the joint. Let the learner notice the direction which tangents take when the rail is in position, and there will be no difficulty in applying the mould or working the piece.

The square sections of plank and rail are given to show the proper application of the bevels. Be careful to apply bevel W properly. Observe that its blade is on the same side of tangent as bevel X.

Having worked the wreath piece to its cylinder form, cut off the under slab square with joint, and at the same time square with line for mitre point. Then cut off the under slab of straight part and work it square with joint and line made by bevel W. The piece will now show a curve on lower corner of concave side. This is a perfect direction for working off remainder of slab, thus forming a ramp from level to rake. Now mark the mitre and cut it partly through, finishing it after the piece is moulded. Complete the wreath by taking off the upper slab.

Fig. 2 shows the construction of a similar wreath, but reversed. Bevels, heights, and letters are the same as in Fig. 1, and the explanation given there will apply here.

Plate 16

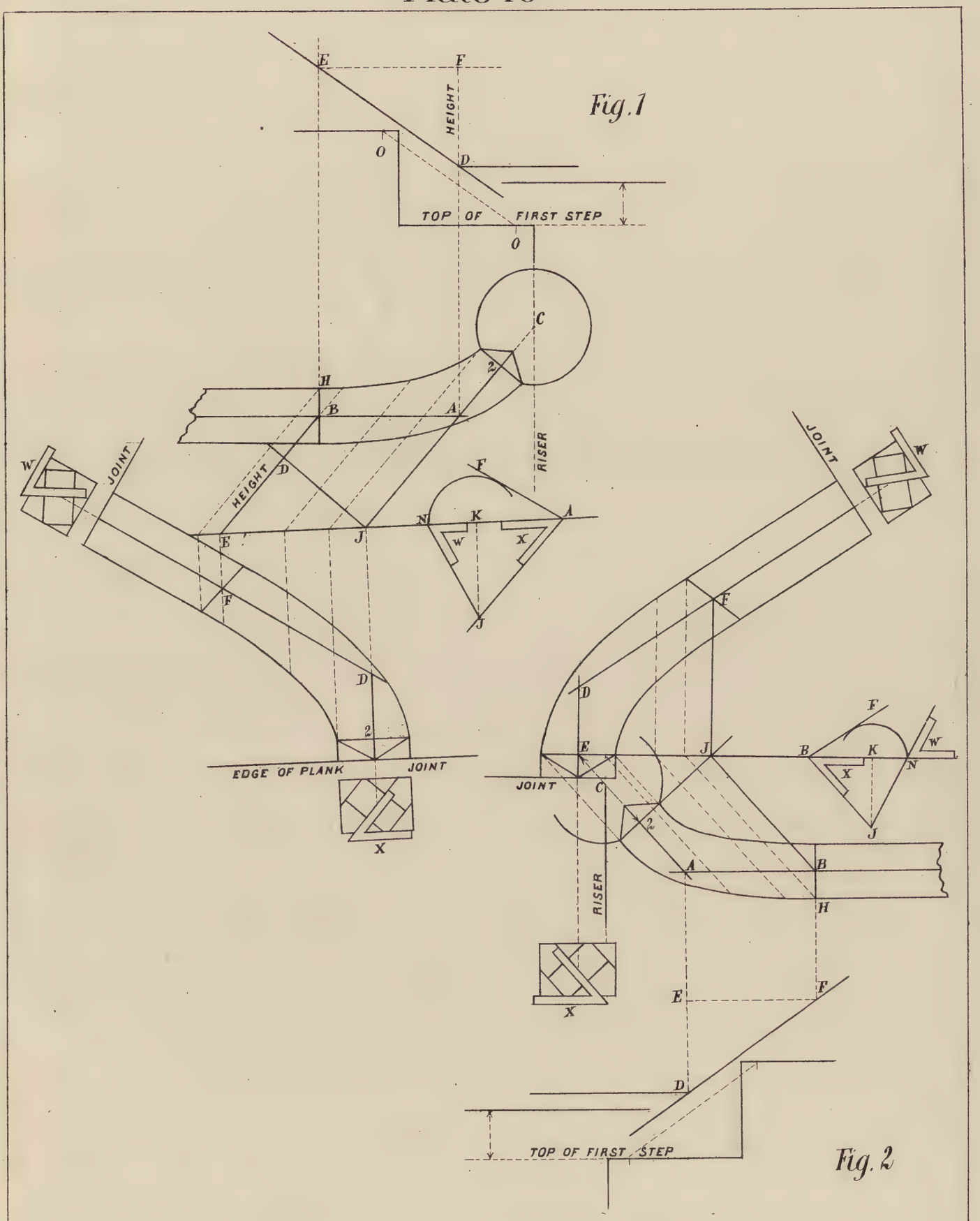

Fig. 1

Fig. 2

FRANKLIN

Plate 17

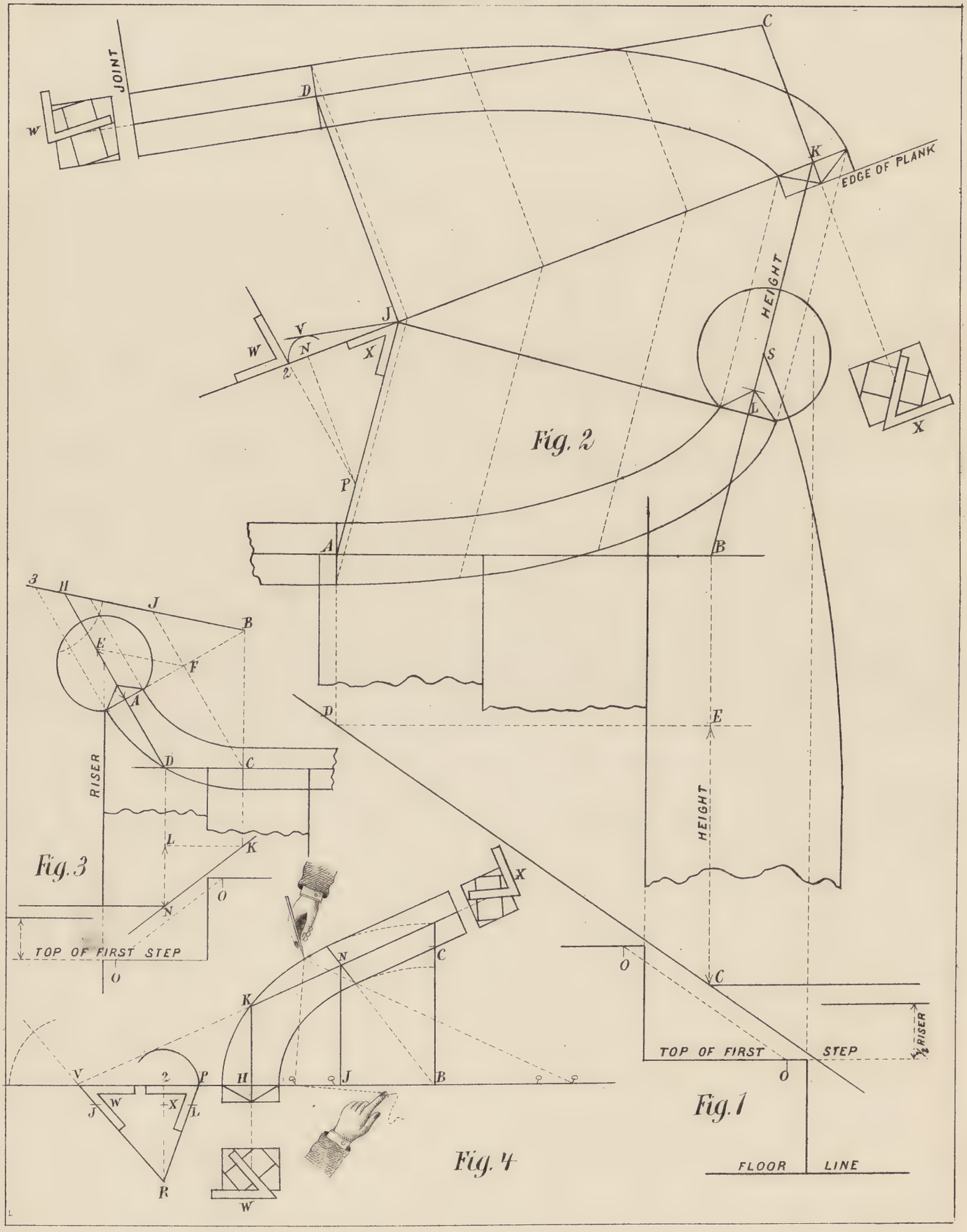
JOINT
EDGE OF PLANK
HEIGHT
RISER
TOP OF FIRST STEP
TOP OF FIRST STEP
½ RISER
FLOOR LINE
Fig. 2
Fig. 3
Fig. 4
Fig. 1

Plate 17.

DESCRIPTION OF SIDE WREATH CONTINUED.

On the right of this plate is shown the construction of a wreath for the starting of first-class stairs. The ends of three steps are curved on the string, which adds greatly to the general effect and finish.

Fig. 1 shows the elevation of square step and floor line. Let under side of rake rail rest on centre of short balusters, O O; set off half its thickness, which draw to any length. The height for newel between top of step and under side of cap should be the same as long baluster. Taking that for the height, mark half a riser from top of step as indicated by an arrow. Set off above this half thickness of rail, cutting the pitch at C. This is a fixed point, and from it draw the dotted perpendicular. From any point on this, as B, square over a line to the left. This is one tangent on ground plan; the other is determined by fixing a point for the projection of newel. This projection, in order to have an easy and extended curve, should be as much as possible, but not to interfere with the passage. Here we will assume S for centre of newel. Then by drawing a line from B through S fixes a level tangent on both plan and wreath. From centre, S, draw the size of cap, and cut off a portion equal to width of rail by a line through L square with B S.

The dotted perpendicular on right of C B represents face of riser. From it set off the width of three square steps as shown. Draw the two parallel curves giving width of rail. This may be done by bending a thin lath. The form of these curves is entirely a matter of taste, but as they approach the mitre cap should be elliptical. They may terminate at any point on the left, as line through A. The first step should be wider than the others, and curved, as shown. We now have a ground-plan. Square down from A, cutting the PITCH at D, and square over from this, cutting the perpendicular at E, which gives C E for height of wreath.

Fig. 2 shows the method of forming the mould. Extend the line through L to the left; draw from A parallel with B S, cutting at J; make height L K equal height C E; draw from K through J. This is pitch of plank. Draw from J and K square with pitch; make K C equal B L, and J D equal J A; draw from C through D. This is tangent on mould. When the rail is in position it stands directly over B A on plan, and to be correct must equal pitch D C on elevation. The line K C falls level when in position. Make the projection below K equal the length of mitre on plan. Draw a few lines through the plan parallel with B S, and cutting the pitch; square these over; find points and trace the curves on mould; add straight wood from D. The angle made by the pitch gives bevel, X, to be applied to the edge of plank, giving a plumb-line for mitre point. The bevel for joint on straight wood is found as follows: Draw J V parallel with D C on mould; from any point, as N, draw N P square with the pitch; take N for centre, and strike an arc touching V J and cutting at 2; draw from P through 2. This gives bevel, W, as required. The application of mould to the plank and working the wreath is precisely the same as explained in the preceding plate.

Fig. 3 shows a method by which the curves on ground-plan are struck from a centre, and the elliptic curves on mould by means of a string. This is certainly a quick and off-hand way of describing the curves, but objectionable from the fact that the radius on plan being limited, the curves described are too short to give a good effect to the work. The question, however, might be asked, Why not increase the radius, and so extend the curve? This would not help the matter, because the tangents would be lengthened at the same time, and change the angle of their intersection on plan, and throw the newel too high. This will be better understood by referring to the figure and following explanation:

First draw the elevation of square step and riser. Let under side of rake rail rest on centre of short balusters, O O; set off half its thickness. If the newel is to be the usual height, set off half a riser from top of first step, and above this draw half thickness of rail, cutting the pitch, and fixing point N; draw a line at any distance above the elevation and parallel with step, as D C. This is centre of rail. Now, determine upon a point for centre of newel on a line with face of riser starting; Square up from N, cutting at D, and from D draw through centre of newel. Next draw size of mitre cap. Cut off a portion of it to equal width of rail by drawing a line through A square with D E; make D C equal D A; draw through C square with D C, cutting the pitch at K, and line through A at B. This makes B a centre, from which strike width of rail on ground plan; draw from C parallel with D A; square over from K, cutting at L. This fixes height of wreath as N L; make A E equal it; join E F; draw from centre B parallel with F E. This is pitch of plank and long diameter of semi-ellipse. Lay the edge of a board on the pitch, and mark points B, J, H; square these over as shown in Fig. 4; make J N and H K, equal C F, and D A Fig. 3; draw from K through N and H. These are tangents on the mould, and to be correct K N must equal pitch K N on elevation; make B C equal B C on plan; set off half width of rail on each side of C; draw from B through N. We will now find bevels for joints. Extend the tangent N K, cutting at V; Transfer pitch of plank from Fig. 3, as follows: Take 3 for centre, and with any radius draw dotted arc; with same radius and with V, Fig. 4, for centre draw an arc of equal length; from its upper point draw pitch through V; Square down a line from any point, as 2, cutting pitch at R; take 2 for centre and strike an arc touching K V, and cutting at P; join P R. This gives bevel X for joint on straight wood. The intersection of pitch and long diameter gives bevel W to apply on square edge of plank, and when in position is a plumb-line or the mitre point of wreath. The exact width of mould is found from the bevels as follows: Set off half width of rail, as 2 X, and draw parallel with V P, cutting both bevels. This gives J V for half width of mould on wide end, and L P as half the width on the straight part. Now find points for pins, and strike curves on the mould with a string. The square sections of plank show the proper application of bevels to joints.

Plate 18.

THE WREATH OVER WINDERS.

In the preceding lessons we have given examples of nearly every form of ordinary stairs having material points of difference. We now come to a class of work that will require still a little more attention. On this plate is shown the construction of a wreath over winders, and starting from a newel. Here it will be in two pieces; the upper piece will form its own ramp; the straight part of it thrown on the same pitch as rake rail over square steps; the curves on mould may be described in the usual way, or traced through points as in the last two plates.

Fig. 1 shows ground plan of stairs, starting with five winders; the narrow ends on centre line of rail are equal to half a square step. Radius for centre line of rail, eight inches. Neither this nor number of winders are limited, but are regulated by the space allowed for the stairs. The newel here stands in a position which gives the best possible effect to the stairs, making them appear wider than they really are. The curve on plan is extended beyond a quarter circle, making tangents for lower piece of wreath form the right angle A B C, and tangents for upper piece, the angle C D E. This determines the joint as shown by the line through C.

Fig. 2 shows elevation. The height of seven risers is given on the left. The tangents on ground plan are unfolded or spread out, as shown by dotted perpendiculars passing through points A, B, C, D, E, corresponding with A, B, C, D, E, on plan. The square step and winder adjoining stand in the same position as on the plan. We will now draw the pitches of wreath. Let under side of rake rail rest on centre of short balusters O O. Set off half its thickness, cutting through E D. Notice here that D being the point fixed by intersection of tangents on plan must also be the point where rake rail ends on the elevation. Draw from D, say through B, and from B through A. The direction of these lines is discretionary, but in fixing point A bear in mind the height of newel, as the pitch A B starting from the mitre cap here differs from that in preceding examples of side wreaths. Were this made level as in those cases, the newel would be too high. Hence the caution in fixing the direction of lower pitch. Draw through joint C, cutting at P N. This gives N E as height for upper piece of wreath. Draw from A, cutting at V. This gives V C as height for lower piece. Now set off the projection of mitre on the cap in Fig. 1 to the right of A, cutting the lower pitch. We will use this when we come to the mould.

To find points for drawing the mould. Extend the pitch C B, cutting at H; form the square as shown, its sides equal to radius A 2 on plan; draw from H, cutting at K; draw from S through K, and from the other corners of the square draw parallels with S K; draw through 2 square with S K; make height Z R equal height V C; draw from R through Y. This is pitch of plank. Make 2, 3, equal 2, 4. Set half width of rail on each side of 3, and square down from these points, cutting at T and F. This gives O F and O T as half diameters for elliptic curves on mould.

To draw the mould, lay the edge of a board on the pitch, and mark the points Y, O, J, R; square these over as shown in Fig. 3; make Y C, J B, and R A, equal Y 4, K S, and the space between Z and corner of square; draw from B through A and C. These are tangents on the mould, and to be correct must equal pitches A, B, C, on elevation. Draw from O through A; make O L equal radius on plan; set half width of rail on each side of L; find points for pins and strike the curves. Now set off on tangent A B projection of mitre to equal that on left of A in elevation.

The bevel W shown in the pitch gives the plumb-line or mitre point across the edge of stuff. The bevel for joint C is found as follows: From any point on long diameter, as F, draw F L parallel with tangent C B on mould; with any point on the pitch as F for centre, and with any radius, draw the dotted arc; from F on the right for centre and with same radius draw an arc of equal length, and from its lower point draw pitch through F; square over from any point as U, cutting pitch at V; with U for centre strike an arc touching L E, and cutting below U; draw from V through this point, which gives bevel X for joint C.

To apply this mould, keep its wide end (which should be left square) fair with edge of plank, the mitre point directly over plumb line made by bevel W on edge of plank. Mark the mitre on surface by the direction shown on mould. After marking the under side in the same manner, take off the slabs and work the piece to its cylinder form. Cut the mitre by the plumb line and the direction marked on surface. Cut off a slab from the under side square with mitre point. Work as near the top surface as the moulding of rail will admit of. Owing to the wreath at this starting-point being on a pitch, the ramp must necessarily be short and abrupt. This, however, is better than having the newel too high.

To draw the mould for upper piece of wreath, extend centre line of rail on plan through E to the left; make E P equal N P on elevation; draw from P through C, and from D and E parallel with P C; from any point on line through P C, as R, square over a line; make height N H equal height N E on elevation; draw from R through H. This is pitch of plank. Draw from R L and H square with pitch; make H E equal N E, L D equal J D, and R C equal R C; draw from D through E and C. These are tangents on the mould, and to be correct must equal pitches E, D, C, on elevation. Find the junction of straight wood and curves by making R 3 equal R 2 and drawing from 3 through E; draw any number of lines through width of rail, parallel with P R, and cutting the pitch; square these over; find the points, and trace the inside and outside curves on mould; draw straight wood parallel with D E; make the joint through C square with tangent, and the mould is complete.

Fig. 4. To find joint bevels, draw a line parallel with pitch in Fig. 1, as that through R D; from any point, as D, draw D C and D E parallel with tangents on mould; take H, Fig. 1, for centre, and with any radius draw dotted arc; with same radius, and from D as centre, draw an arc of equal length; from its upper corner draw the pitch through D; square down from any point as U, cutting pitch at V; with U for centre strike an arc, touching D E, and cutting at T; join T V. This gives bevel X for joint on straight wood. From same centre strike an arc, touching C D, and cutting at 2; draw from V through 2. This gives bevel W for joint C. The square sections show application of bevels.

Plate 18

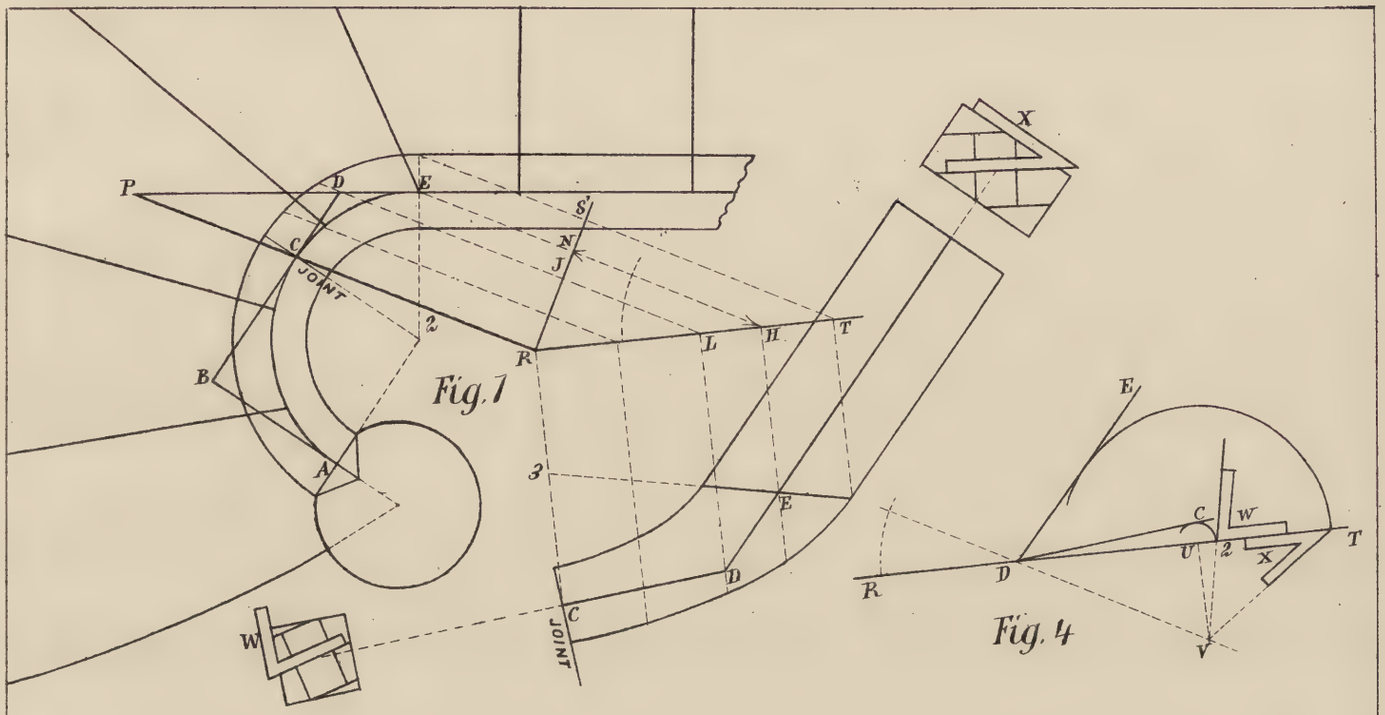

Fig. 1

Fig. 4

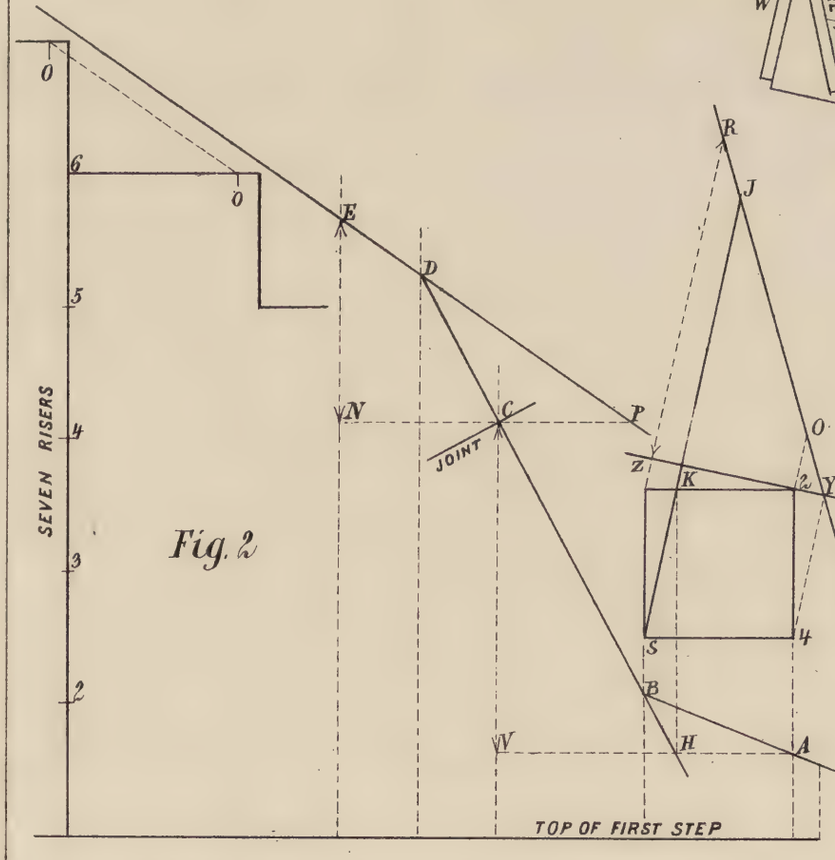

Fig. 2

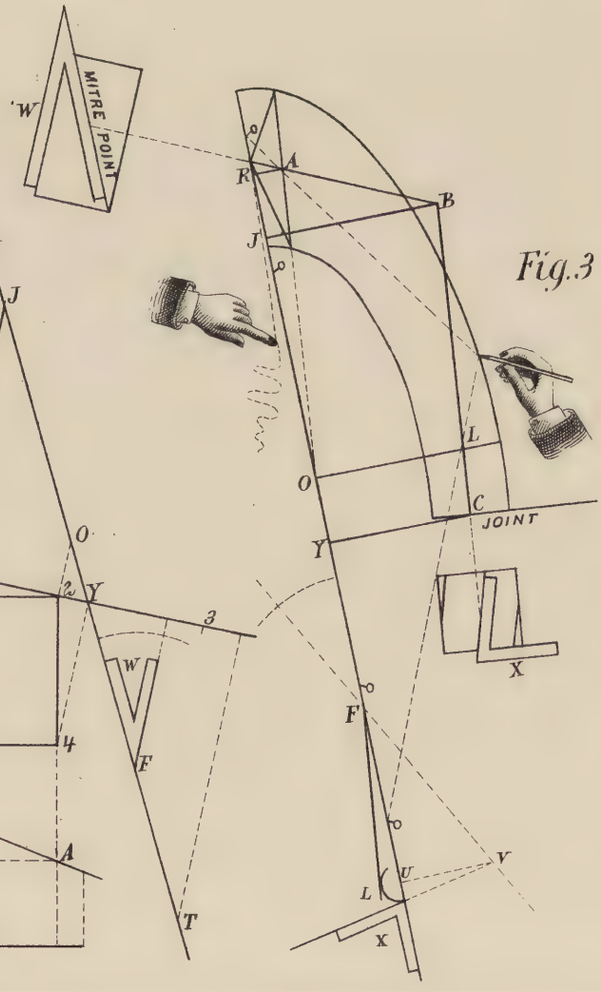

Fig. 3

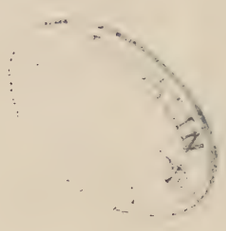

Plate 19

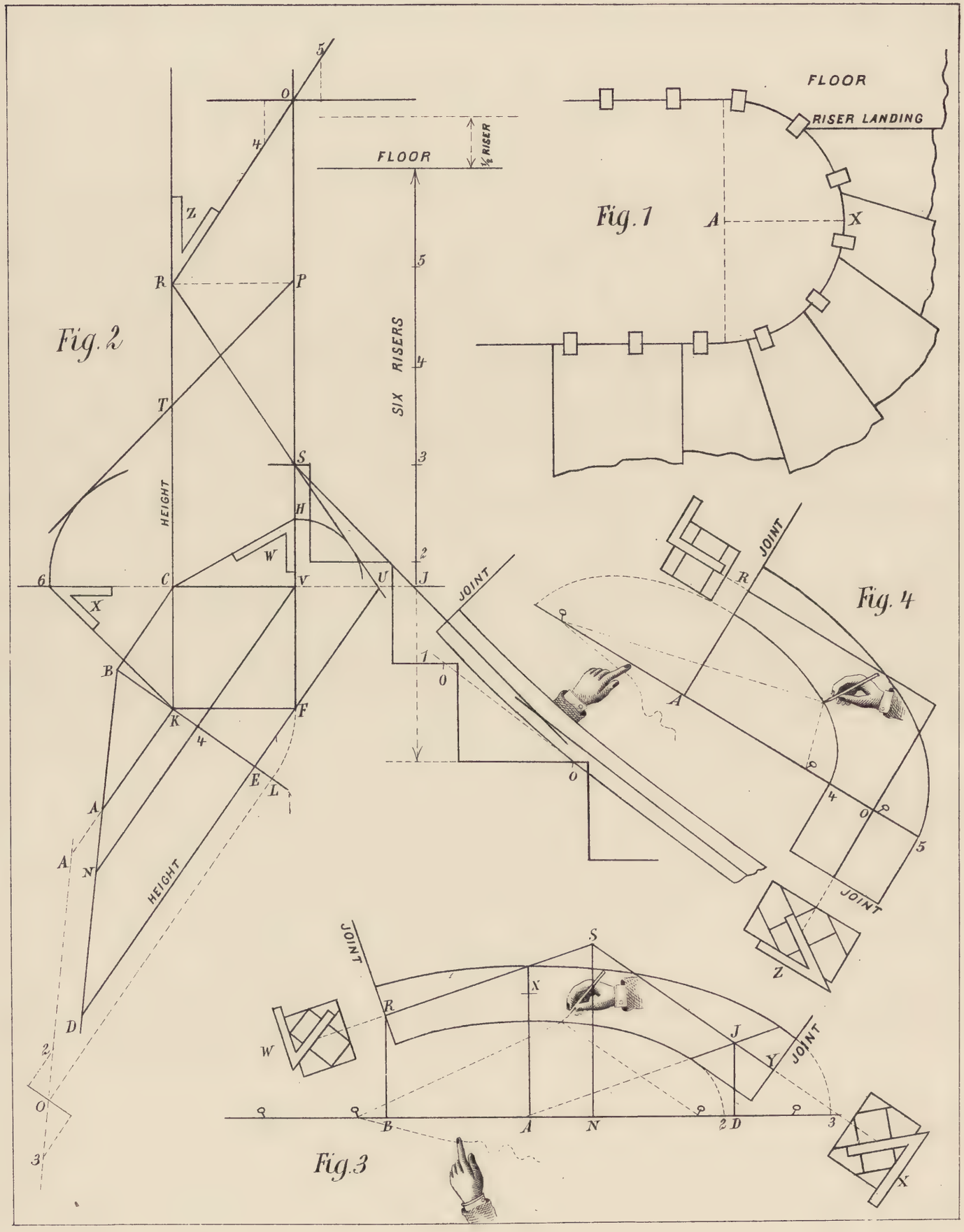
FLOOR
RISER LANDING
A
X
Fig. 1
FLOOR
⅛ RISER
SIX RISERS
HEIGHT
JOINT
Fig. 2
Fig. 4
Fig. 3
Z
W
X
Y
R
P
S
T
H
C
V
U
J
B
K
F
E
L
A
N
D
O

PLATE 19.

THE WREATH OVER FIVE WINDERS LANDING ON A LEVEL FLOOR.

FIGURE 1 shows a ground plan, well adapted for either large or small halls. The cylinder here is nine inches radius, but may be more or less to suit length of step and space allowed. The narrow ends of winders on centre line of rail are equal to half a square step. The mould for this wreath is easily obtained. First find the number of risers over which it will stand; counting from square step we find six. With this and the radius A X we proceed as follows:

Fig. 2. Here unfold twice the radius as shown by perpendiculars. Then make the elevation of square step and winder adjoining it, which now stand in the same position as on the plan. Set off six risers from top of square step, and draw floor line; above this mark half a riser, as shown by the arrow, and from it set off half thickness of rail cutting through perpendicular at O. We are now ready to draw lower pitch of wreath to connect with a ramp over square step. To do this assume any point on half thickness of rake rail over square step, as shown by the intersection. From this point draw through corner of winder above U, cutting perpendicular at S; divide S O equally, as P; square over P R; draw from R through O and S. Pitches are now given as J, R, S, for lower piece of wreath, and R O for the upper. Square over a line from J, cutting through perpendicular on the left, giving points V C, below which form the square. Now extend pitch R S, cutting at U; draw from it through F; again draw from the other corners of square parallel with U F; then draw through K square with U F. Make height E D equal height C R; join D B. This is pitch of plank for lower piece of wreath. Find half long diameter of semi-ellipse by making K L equal K F; square up from L, cutting dotted line at O; draw through this parallel with L B; set half width of rail on each side of O, and we have A 2 for inside curve on mould and A 3 for outside curve. To find joint bevels, make R T on the left equal V S on the right; draw from P through T; take C for centre and strike an arc touching T P, and cutting at 6; join 6 K.

This gives bevel X for lower joint. Now take V for centre and strike an arc touching U S and cutting at H; join H C. This gives bevel W for centre joint. The bevels being complete for lower piece of wreath. The mould is formed by laying a board on the pitch and marking points B, A, N, D; square these over as shown at

Fig. 3. Here make B R, N S and D J, equal B C, 4 V and E F, Fig. 2; draw from S through R and J. These are tangents on the mould, and to be correct must equal pitches J, S, R on elevation. Draw from A through J; make A X equal radius on plan; set half width of rail on each side of X; make J Y equal distance between J and joint of ramp on elevation. Now find points for pins and strike the curves. Make the joints square with tangents. This completes the mould for lower piece of wreath. The square sections of plank and rail show application of bevels to joints.

The mould for upper piece of wreath is found from elevation at Fig. 2. Set half width of rail on each side of O; draw perpendiculars, cutting the pitch at points 4 and 5. This gives R 4 for half long diameter of inside curve, and R 5 for outside curve on mould. The bevel Z applies to upper joint of wreath. Have a board sufficiently wide as shown at

Fig. 4. Draw any line for long diameter, as that through A; Make A, 4, O, 5, equal R, 4, O, 5 on elevation; square over from A; make A R equal radius on plan. Set off half width of rail on each side of R. Now find points for pins and strike the curves; Draw tangents through the mould at right angles as shown; add four or five inches of straight wood from O. The section of plank and rail shows application of bevel Z to the upper joint. The centre joint, being on the short diameter, makes width of mould the same as rail. Hence a square is applied to joint, as shown, and equal slabs cut off both surfaces of plank.

If it is desirable to save material, this piece may be cut by a rough pattern of a parallel width the same as rail. But the mould must be retained and applied as drawn, as a correct mould is absolutely necessary in giving this or any wreath its true cylinder form.

PLATE 20.

THE WREATH OVER WINDERS AND LANDING ON A FLOOR.

FIGURE 1 is a plan similar to that on preceding plate, and showing how the lower part of wreath may be made to form its own ramp and still have a regular height over the winders. This is a decided advantage, effecting not only a saving of time but also of expense, as it gives the opportunity for using machine-worked straight rails.

The construction of this wreath differs from the last, only in changing the joint to a position that will shorten the tangents for lower piece of wreath, and prevent the pitch over square steps from running too far into the cylinder. This will be seen when we make the elevation of pitches for the wreath. Let us assume the line through C as the joint. This gives A, B, C, as tangents for lower piece of wreath, and C, D, F, for the upper piece. The number of risers from square step to floor is six. The narrow ends of winders on centre of rail are equal to half a square step. We now proceed and make the elevation of pitches.

Fig. 2. Here the tangents are unfolded as shown by dotted perpendiculars passing through points T, R, F, N. The elevation of square step and top of winder are shown on left of spring line. The height from top of square step to floor is shown on the right. The under side of level rail is half a riser above the floor. Half its thickness is drawn above, cutting the perpendicular, and fixing point N. Draw under side of rake rail over square step, resting on centre of short balusters; set off half its thickness, cutting through T and R; draw from R through N. We have now the pitches for both pieces of wreath. The height for lower piece is found by squaring over from T, cutting the perpendicular at C, giving C F for height; square over from F, cutting at D, which gives D N for height of upper piece.

Now proceed and find the mould for lower piece of wreath. Extend the pitch N R, cutting at P, giving C P on dotted line. Transfer this distance to plan, extending tangent C B to equal it; Draw from P through A; draw from B and C parallel with P A; also draw from the centre, square with P A, giving J; make height V L equal height C F, Fig. 2; join L J. This is pitch of plank. To find half long diameter for semi-ellipse, draw any line parallel with pitch; extend centre line of rail, cutting below J; square up from this point and from the centre, cutting at H and O; set half width of rail on each side of O, giving H 7 and H 8 for half diameters of inside and outside curves on mould.

Fig. 3. Have a board of sufficient width, and draw a line on its face; mark points J, K, L, to correspond with same points on pitch, Fig. 1; square these over, and make J T, K R, and L F, equal J A, E B, and V C, Fig. 1; draw the tangents from R through T and F. These to be correct, must equal pitches T, R, F, Fig. 2. Make L F equal radius on plan; set half width of rail on each side of F; find points for pins, and strike the curves as shown; draw from centre H through T; add straight wood parallel with R T; Extend the long diameter, and from any point on it, as H, draw line H R parallel with tangent R T on mould. Transfer pitch of plank from Fig. 1 as follows: From L, as centre, and with any radius, draw dotted arc. With same radius and from H, Fig. 3, as centre, draw an arc of equal length; from its lower corner draw the pitch to H; square down from any point, as V, cutting pitch at U. With V for centre, and a radius touching H R, strike an arc cutting at S; join S U. This gives bevel Z for joint on lower piece of wreath. Joint F is made so near the centre line that the variation from a right angle is not perceptible, therefore use a square as shown.

The mould for upper piece of wreath is found as follows: Extend the tangent B C, Fig. 1, through D; draw from centre of semicircle and through F, parallel with C D. Square over from D, cutting at 2; make height D 4 equal height D N on elevation; join 4 2. This is pitch of plank.

Fig. 4. Upon a board of sufficient width, draw any line for long diameter; set off 2, 3, 4, to correspond with same points on pitch, Fig. 5; square these over and make 2 S and 4 N, equal S F and C D, Fig. 1; join S N. This line is tangent on mould, and to be correct must equal pitch F N on elevation; draw the tangent from N through 4, giving direction for straight wood. Make 3 K equal radius on plan, and set half width of rail on each side of K. Find from Fig. 5, by the method before explained, half the long diameter of semi-ellipse and strike the curves on mould.

Bevel X in elevation is applied to upper joint as shown. The bevel for joint S is found as follows: From any point on a line parallel with the long diameter, as 4 (on the line to the right), draw 4 F parallel with tangent N S on mould.

Transfer pitch of plank as follows: From 4, Fig. 5, as centre, draw dotted arc of any radius. With same radius return to point 4 and draw an arc of equal length. From its lower corner draw the pitch through 4; square up from any point, as N, cutting pitch at H; with N for centre, and a radius touching F 4, strike an arc cutting at 3; join 3 H, giving bevel W for joint S. Its application is shown by the section opposite.

Plate 20

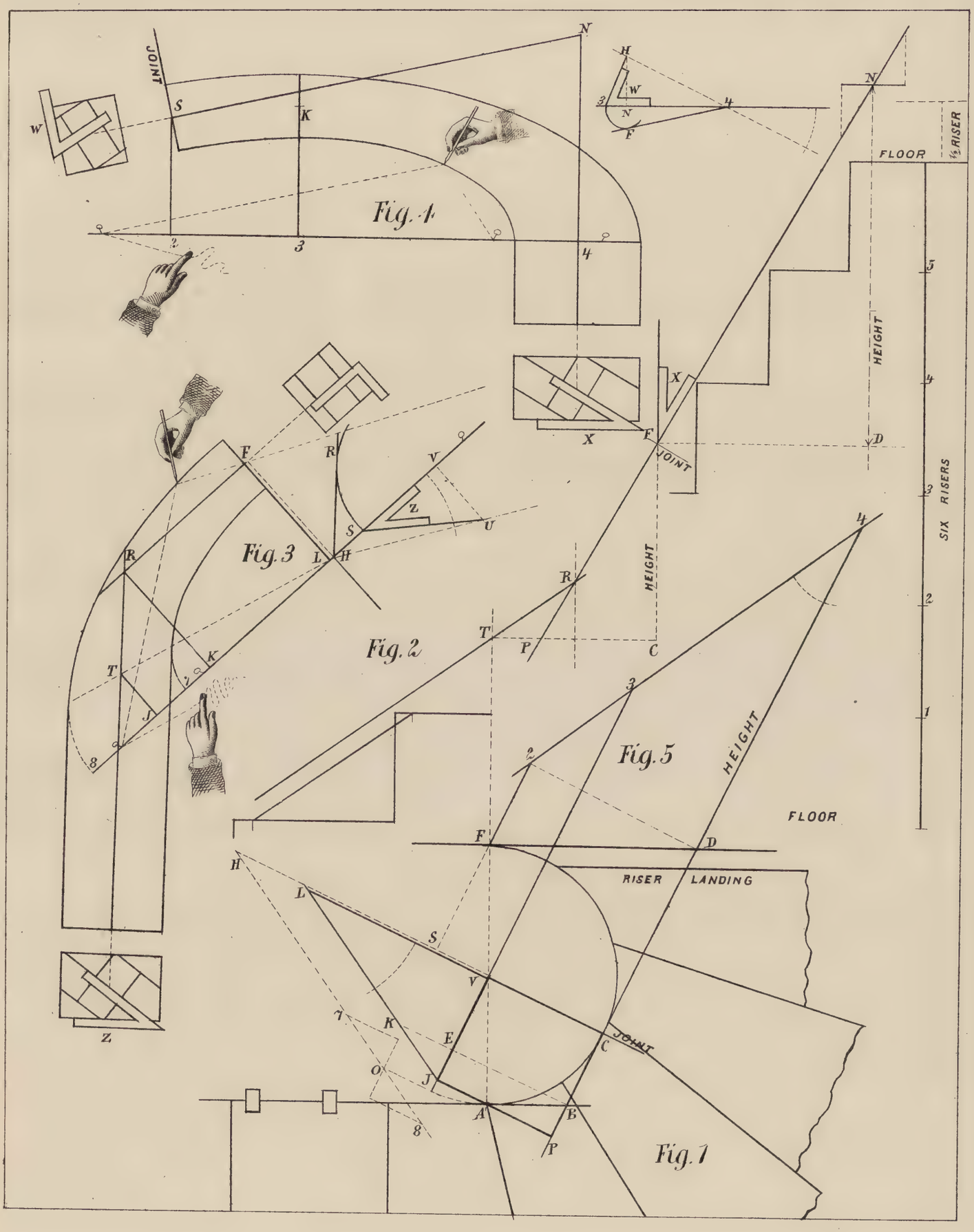
JOINT
W
S
K
N
2
3
4
Fig. 4
H
W
3
N
4
F
N
FLOOR
½ RISER
HEIGHT
5
4
3
SIX RISERS
2
1
X
F
D
JOINT
F
R
V
Z
S
U
L
H
Fig. 3
R
T
K
J
8
Z
T
P
C
R
HEIGHT
Fig. 2
4
3
2
HEIGHT
Fig. 5
FLOOR
F
D
RISER
LANDING
H
L
S
V
7
K
E
JOINT
C
O
J
A
B
8
P
Fig. 1

Plate 21

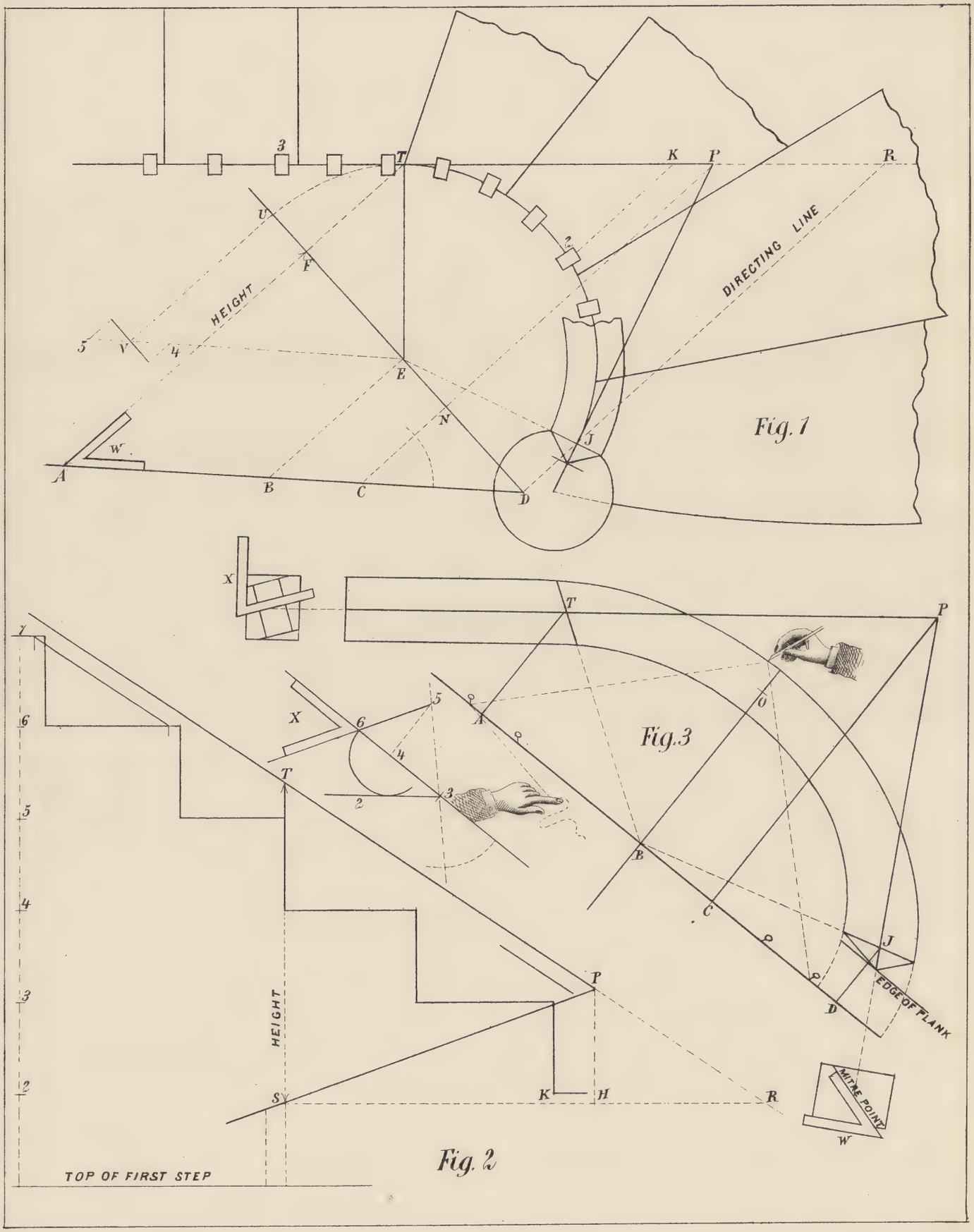
3
T
K
P
R
U
F
HEIGHT
DIRECTING LINE
5
V
4
E
N
J
W
A
B
C
D
Fig. 1
X
T
P
Y
6
X
5
4
T
3
2
A
B
C
D
J
EDGE OF PLANK
Fig. 3
HEIGHT
P
S
K
H
R
MITRE POINT
W
TOP OF FIRST STEP
Fig. 2

Plate 21.

THE WREATH OVER WIDE WINDERS.

Figure 1 shows the plan of stairs, in which the width of winders, at their narrow ends on centre line of rail, is eight inches, and the width of a square step ten inches. When this is the case, or when the widths approximate these, the upper part of wreath may be on the same pitch as rake rail over square steps. The balusters on winders will be one and a quarter inches longer than those on square step: the difference is so slight as not to be noticed when the rail is in its position. The radius for centre line of rail is fifteen inches, and struck from centre E. The curve extends beyond a quarter circle, and terminates on line through J at mitre cap. The tangent J P being square with J E, makes T P equal J P. The number of risers on plan is seven.

Fig. 2 shows the elevation: Draw any line for top of first step, and set off from it the height of seven risers. Draw any perpendicular, as that through S T. This represents the spring line. Set off to the right of it the distance T P on the plan, and draw the dotted line P H. Then, on the left of S T, make the elevation of a square step and winder to equal those on plan. Let under side of rake rail rest on centre of short balusters. Set off half its thickness, cutting through spring line at T, and ending at P. This is upper pitch of wreath. The point P being fixed, draw the lower pitch from it, say through S. This point is nearly half a riser higher than in preceding example. Here we increase height of newel in order to flatten the pitch from P, and make it less difficult in forming the easing on lower part of wreath starting from mitre cap.

The height for wreath is now fixed at S T. We find a directing line for pitch of plank by drawing from S to the right, and cutting extended pitch at R, giving the distance R S. Transfer this to plan, extending tangent T P to equal it, giving point R. Draw from R through J; draw from P, T and through centre E parallels with R J; again draw through centre E square with R J, cutting at D; make height F A equal height S T on elevation; draw from D through A. This is pitch of plank. Draw from centre E parallel with the pitch; make E U equal E T; square up from U, cutting at V; set half width of rail on each side of V. This gives E 4 and E 5 as half long diameters for inside and outside curves on mould.

Lay the edge of a board on the pitch, and mark the points A B C D; square these over as shown at Fig. 3; make A T, C P, and D J, equal F T, N P, and D J on plan; draw the tangents from P through J and T. These to be correct must equal the pitches S, P, T, Fig. 2. Draw from B through T and J; make B O equal radius on plan; set off half width of rail on each side of O; find points for pins and strike the curves; add straight wood from T.

In setting off length of mitre on tangent below J, observe that the plank here is on a pitch, and this causes the mitre on surface of plank to be longer than that shown at the cap. To obtain it correctly, transfer the length from J on ground plan to the left of S, Fig. 2, indicated by a line cutting the pitch. The exact length is now given on the pitch. After setting this off below J, draw the end of mould parallel with long diameter.

The angle made by pitch of plank at Fig. 1 gives bevel W, which is applied to edge of plank, giving a plumb line for mitre point. The bevel for joint on straight wood is found as follows: From any point on a line parallel with long diameter, as 3 (on line through 3, 6), draw 3, 2, parallel with tangent T P on mould. Transfer pitch of plank as follows: With C, Fig. 1, for centre, and any radius, draw dotted arc; with same radius, and from 3 as centre, draw an arc of equal length; from its lower corner draw the pitch through 3; Square up from any point, as 4, cutting the pitch at 5; with 4 as centre and a radius touching 3, 2, strike an arc, cutting at 6; draw from 5 through 6. This gives bevel X as required. Its application is shown by the section opposite.

Work this wreath by the method explained in plate 18, in which is shown a similar construction. It might be well to mention, however, that when the wreath is worked to its cylinder form and the lower slab cut off square with the mitre, the height should be tested. This may be done by standing the piece on a level surface and measuring up to half thickness of rail on spring line. This to be correct should equal S T, Fig. 2. In case, however, of any slight variation in this, the newel may be set to suit it.

To find the exact difference in length of balusters marked 2 and 3: Draw from the centre of 2 parallel with R J, cutting at K. This determines the distance T K on upper tangent; set this off to the right of S on dotted line, Fig. 2, giving K; square up from K to under side of rake rail. The space at this point between the top of step and under side of rail is the difference in length of balusters.

PLATE 22.

THE WREATH STARTING FROM A NEWEL.

FIGURE 1 shows the plan of stairs starting with curved risers. The ends of square and curved steps on centre line of rail are of equal width, making balusters under the wreath and straight rail the same length. The radius for centre line of rail is twenty-two inches, and its curve less than a quarter circle, its centre being E, and the tangents are A B C.

Fig. 2. The dotted perpendiculars through A B C show the tangents unfolded. The perpendicular through C represents spring line E C on plan. Make the elevation of three risers with square steps standing in the same position as those on plan. Let under side of rake rail rest on centre of short balusters O O. Set off half its thickness, cutting through tangents C, B, and fixing B as a point from which to draw lower pitch. It will be seen that to draw this from B parallel with the steps, would throw the lower part of wreath too high. Therefore assume line B A for lower pitch. This makes height of newel nearly the height of a riser—more than a short baluster. Now transfer length of mitre from cap, and set it off from perpendicular through A, cutting the pitch to the right of A. To find height of wreath and directing line for pitch of plank, Draw from A to the left, cutting at 6, giving 6 C as height; extend pitch B C, cutting at D, giving 6 D; transfer this distance to upper tangent on plan, making C D equal it; draw from D through A; also draw from B and C parallel with D A; now draw through centre E square with D A; make height 6.5 equal height 6 C on elevation; join 5.2. This is pitch of plank. Draw any line parallel with pitch; make E F equal E C; square up from E and F, cutting at 3 and O; set half width of rail on each side of O, as shown, Then 3 J and 3 L will be half the long diameters of curves on the mould.

Now lay the edge of a board on the pitch, and mark the points 2, 3, 4, 5; square these over as shown in Fig. 3; make 2 C, 4 B, and 5 A, equal 2 C, N B, and 6 A, Fig. 1; draw the tangents from B through A and C. These to be correct must equal pitches A, B, C, Fig. 2. Draw from 3 through A and C; make 3 E equal radius on plan; set half width of rail on each side of E; find points for pins, and strike the curves; set off length of mitre, taken from pitch, Fig. 2, on tangent beyond A, and draw end of mould by it, parallel with long diameter. We will again state that the end of mould is to be left straight, and not cut by the mitre. The lines on it give a direction to mark the mitre on surface of plank. The bevel X in angle of pitch, applied to the edge of the plank, gives a line which will be plumb when the wreath is in position; In applying the mould to either side, Let lower end be kept fair with edge of plank, and mitre point directly over the line made by bevel X.

Fig. 4. To find a bevel for joint on straight wood. From any point, on a line parallel with long diameter, as K, draw a line K P parallel with tangent B C. Transfer pitch of plank from Fig. 1 as follows: With 5 for centre and any radius draw dotted arc; with same radius, and from K as centre, draw an arc of equal length; from its lower corner draw the pitch through K; square up a line from any point, as J, cutting the pitch at T; with J for centre and a radius touching K P strike an arc, cutting at V; join V T, which gives bevel W for upper joint.

The arrangement of this plan is such as to produce the best possible effect in every part of the stairs. Particular care should be taken to have the mitre accurately cut; for if there be the least variation from the exact length, either wreath or newel will be thrown from its true position and the balusters stand out of plumb.

Plate 22

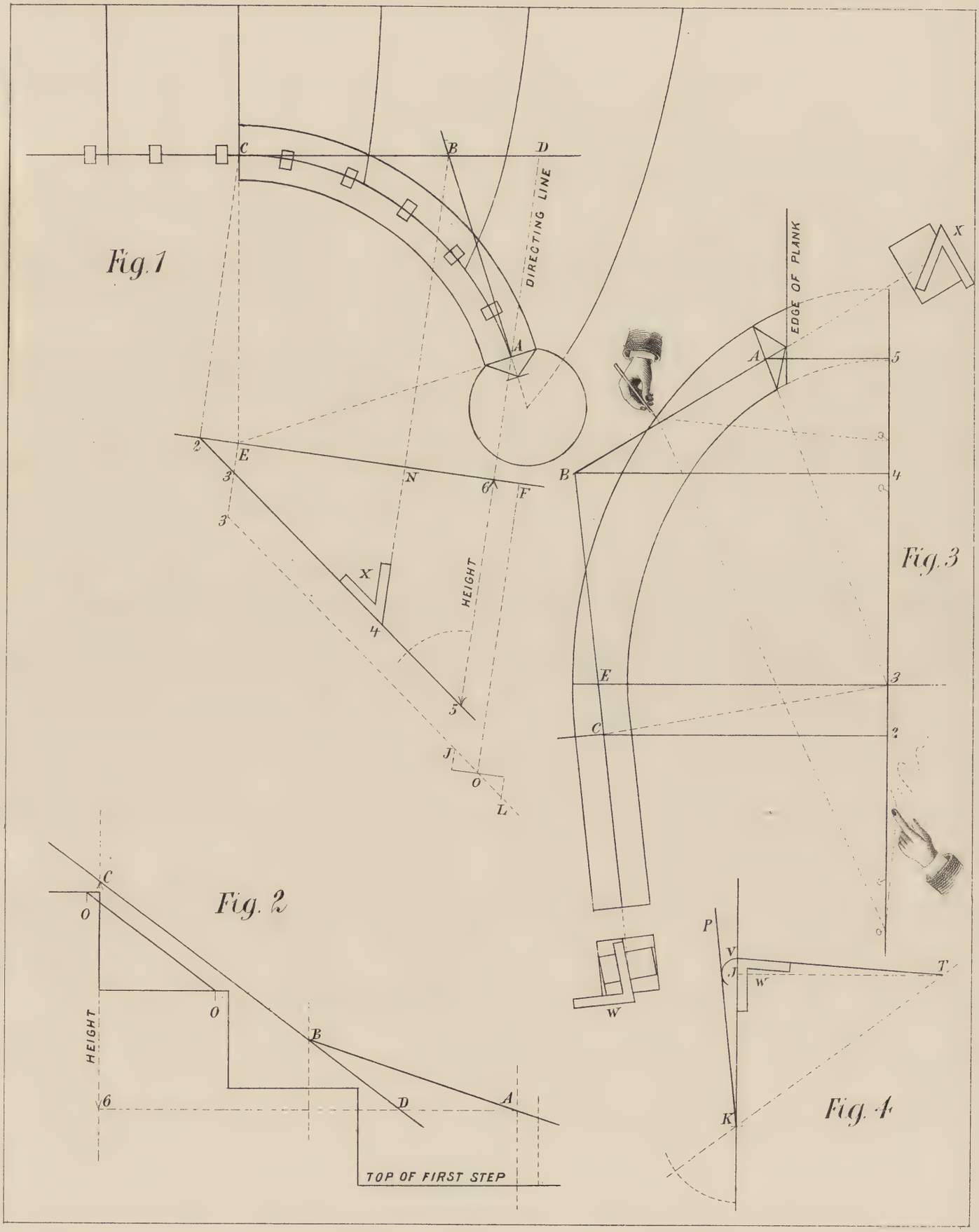
C
B
D
DIRECTING LINE
A
2
E
3
N
6
F
3
X
4
HEIGHT
5
J
O
L
Fig. 1
EDGE OF PLANK
X
A
5
3
B
4
E
3
C
2
W
Fig. 3
C
O
O
HEIGHT
B
6
D
A
TOP OF FIRST STEP
Fig. 2
P
V
J
T
W
K
Fig. 4

Plate 23

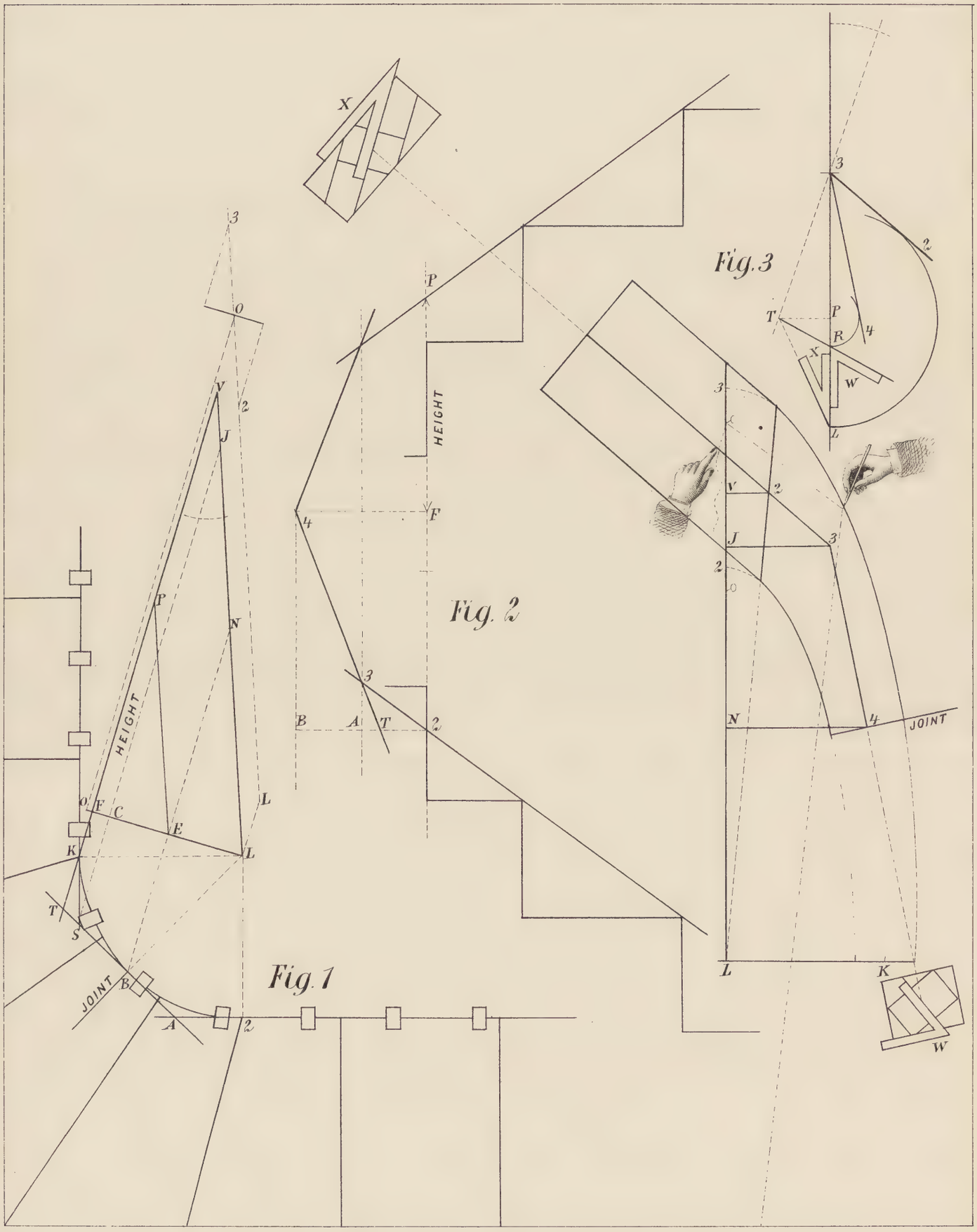
X
3
0
V
2
J
P
N
HEIGHT
O
F
C
E
K
L
T
S
JOINT
B
A
2
Fig. 1
P
HEIGHT
4
F
3
B
A
T
2
Fig. 2
3
2
T
P
R
4
X
W
L
Fig. 3
V
2
J
3
2
0
N
4
JOINT
L
K
W

PLATE 23.

THE WREATH OVER FIVE WINDERS AND AROUND A QUARTER CIRCLE.

FIGURE 1 shows a plan of quarter circle stairs, having five winders, with square steps above and below. The number of risers counting from square step and including riser above is eight. The wreath to be in two pieces, each forming its own ramp, having straight wood thrown on the same pitch as rake rail over square steps. To do this, divide the quarter circle equally, as B; and from centre L, draw a joint through B. This makes equal tangents on the plan, as 2 A B, and B S K. By unfolding two of these we find height and pitches of the wreath.

Fig. 2. Here unfold tangents 2 A B of plan, and through which draw perpendiculars; that through 2 F P represents the spring line. The winder and square step above, and below, stand from the spring line the same as those on plan, and the whole number of risers is eight. Proceed and draw the pitches through corners of square steps, cutting the spring line at points 2 and P. Divide this distance equally as F; square over from F, cutting at 4; draw from 4 through 3. This gives 2 3 4 as pitches for one-half the wreath; and F P is one-half the height. Find the direction of a line for pitch of plank, by squaring over from 2, cutting at B. This gives B T. Extend tangent B S on plan to equal B T, Fig. 2, and draw from T through K; next draw from B and S parallel with T K; again draw from centre L square with T K. Make height F P equal that of F P, Fig. 2; join P E. Now draw from L parallel with E P, cutting at V. This is pitch of plank.

Find half long diameter of semi-ellipse, by drawing any line parallel with the pitch. Make L O equal L K. Square up from this point, cutting the pitch in O, and on each side of O set off half width of rail. This gives L 2 for inside curve on mould, and L 3 for outside curve. Lay a rod on the pitch and mark the points L, N, J, V, Upon a board; draw a line for the long diameter as shown on the right. Mark the points L, N, J, V, from the rod and square them over. Make N 4, J 3, and V 2, equal E B, C S, and F K, Fig. 1. Draw the tangents from 3 through 2 and 4. These to be correct must equal the pitches 2, 3, 4, Fig. 2. Draw from L through 2. Make L K equal the radius on plan and set half width of rail on each side of K. Find points for pins and strike the curves; add straight wood parallel with tangent 3, 2, and make the joint through 4 square with tangent.

Fig. 3 shows the joint bevels. From any point on a line parallel with the long diameter, as 3, draw 3, 2 and 3, 4 parallel with tangents on mould. Transfer pitch of plank as follows: From V, Fig. 1, as centre, and with any radius, draw dotted arc. With same radius and 3 for centre draw an arc of equal length. From its upper corner draw the pitch through 3; square over from any point, as P, cutting pitch at T. With P for centre, and a radius touching 3, 2, strike an arc, cutting at L; join L T. This gives bevel X for upper and lower joints of wreath. With same centre, and a radius touching 4 3, strike an arc, cutting at R; draw from T through R. This gives bevel W for centre joint. The application of bevels are shown by the sections.

A saving of material may be effected in cutting the piece to a parallel width by a rough pattern; but the mould as drawn is necessary in giving the piece its cylinder form. In working it is best to tack the mould to the piece, and when bolting the centre joint be careful to keep the lines made by bevel W on each piece exactly opposite.

Plate 24.

THE WREATH STARTING FROM A NEWEL AND STANDING OVER FOUR WINDERS.

Figure 1 shows plan of stairs often adopted by country carpenters, who, as a rule, omit the rail, leaving that for others to put up. Their stairs often present an awkward arrangement, for in planning them they seldom pay any attention to the rail that is to follow. In this plan the newel stands in such a position as to shorten the winder starting, and give to the whole stairs a contracted appearance. All this could have been improved by simply extending the curve as shown in previous examples; but now the position of newel is fixed, and everything complete except the rail. The wreath will be in two pieces—the upper piece to form its own ramp, with straight part thrown on the same pitch as rake rail over square steps, and the lower piece forming an easing starting from mitre cap. It will be necessary to place the joint in such a position as will make the upper tangents shorter than the lower ones. This is shown on the plan. The joint being drawn through C makes the upper tangents form the angle C D E, and gives for lower tangents the angle A B C. The number of risers shown on plan is six.

Fig. 2. The perpendiculars through A, B, C, D, and E show the tangents unfolded, those through A and E representing spring lines A and E on plan. Draw a line for top of first winder as shown. Set off from this the height of four risers on line to right giving a point as E. From this draw the elevation of a square step. Let under side of rake rail rest on centre of short balusters O O. Set off half its thickness, cutting through E and D. This fixes D as a point from which to draw, say through B, and from B through A. This gives A B as the pitch starting from mitre cap. Square over from A, cutting at K. This gives K C as height for lower piece of wreath. Draw through C, cutting at F and H, giving H E as height for upper piece.

To find the mould for upper piece of wreath: Extend tangent E D on plan to equal H F, Fig. 2. Draw from F through C, and from D and E parallels with F C. Now draw any line square with H C, as H J. Make height J L equal height H E, Fig. 2. Join L H. This is pitch of plank. Draw from H P L square with pitch. Make L E, J D, and H C equal J E, S D, and H C on the left. Draw the tangents from D through E and C. These to be correct must equal E D C, Fig. 2. To find the junction of straight wood with curves on mould, make H 2 equal H 2 on the left. Draw from 2 through E. Before proceeding further, it is understood that this wreath is to form its own ramp. In doing so, the surface of plank is thrown on two pitches, so that a line across its upper edge would be almost parallel with a step. Now if we give this mould its exact cylinder form and cut the stuff by it, there would undoubtedly be a waste of material, and, while we repeat that no parallel mould for an inclined wreath can be correct, we may allow the use of one in this case. The convex curve nearly forms the ramp, and the concave curve, being much shorter, gives a line on surface of plank which some may deem sufficiently correct. Allowing this, we will proceed and find the curve through centre of mould. Set off from each side of it half width of rail, and trace the inside and outside curves. Cut the stuff full for this piece of wreath. To find joint bevels: From any point on a line parallel with pitch H L, as D (on the line to the right), Draw D C and D E parallel with tangents on mould. Transfer pitch of plank as follows: With L, [Fig. 1] for centre and any radius draw dotted arc. With same radius and D for centre draw an arc of equal length. From its upper corner draw pitch through D. Square down a line from any point, as A, cutting the pitch at B. With A for centre and a radius touching D E strike an arc, cutting at L. Join L B. This gives bevel X for upper joint. From same centre, and with a radius touching D C, strike an arc, cutting to the right of A. Draw from B through this point, which gives bevel W for centre joint. The application of bevels are shown by square sections of rail.

The mould for lower piece of wreath is found as follows: Extend tangent C B on plan to equal N K on elevation. From its extended point, N, draw through A. Then from B and C draw parallel with N A. Now draw any line, as that through K, square with K, A, N. Make height K C equal height K C on elevation. Draw from J through C. This is pitch of plank. Again draw from J R C square with pitch. Make C A equal K A, R B equal T B, and J C equal J C. Draw tangents from B through C and A, which to be correct must equal pitches A B C on elevation. Now draw any number of lines through width of rail on plan, cutting the pitch. Square over from the intersections and find points, through which trace the curves on mould. Make J S on the right equal J S (above). Draw from S through A. Set off length of mitre to the left of A on tangent, taking it from lower pitch on elevation, and through the point thus given draw end of mould parallel with pitch C J. The bevel in the angle made by pitch is to be applied to edge of plank, giving plumb line for mitre point. The bevel for joint C is found as follows: Draw 2, 3, parallel with tangent B C. Square over by the pitch from any point, as V, cutting at R. With V for centre, and a radius touching 2, 3, strike an arc, cutting at P. Draw from R through P. This gives bevel Z for joint C. Its application is shown by section opposite.

The application of the mould is the same as in preceding examples. If desired, the stuff may first be cut to a parallel width. The plumb line for mitre cut being on square edge, is a direction to cut off the slabs and form the mitre. The mitre should be cut by a bevel set to the plan, and not by a square, as it differs from a true mitre.

Plate 24

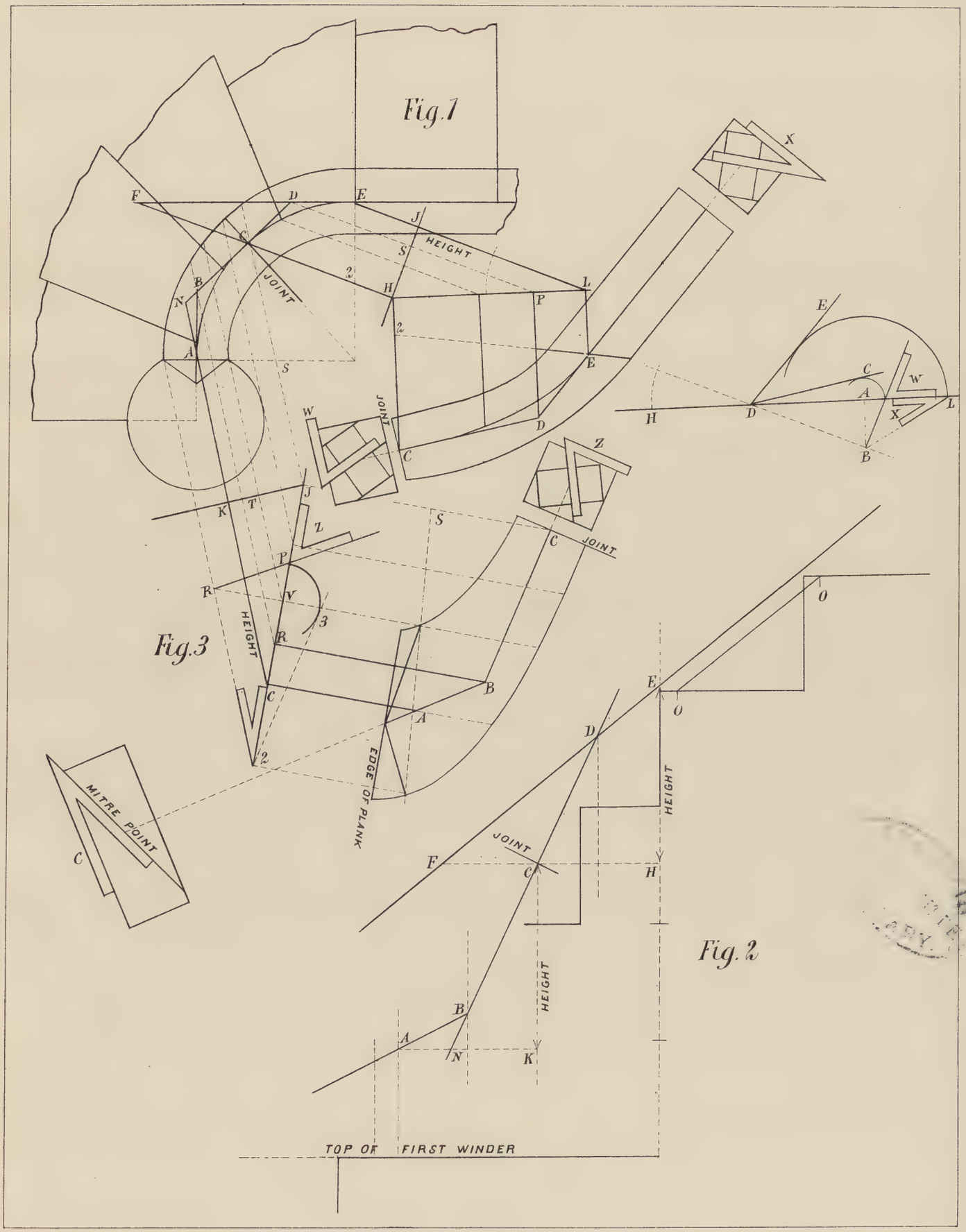
Fig.1
F
D
E
J
HEIGHT
S
C
JOINT
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N
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E
W
JOINT
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X
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D
X
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B
Z
K
T
J
L
S
C
JOINT
P
R
V
3
HEIGHT
Fig.3
R
C
B
A
2
EDGE OF PLANK
MITRE POINT
C
O
E
D
HEIGHT
JOINT
F
C
H
Fig.2
B
A
N
K
HEIGHT
TOP OF FIRST WINDER

Plate 25

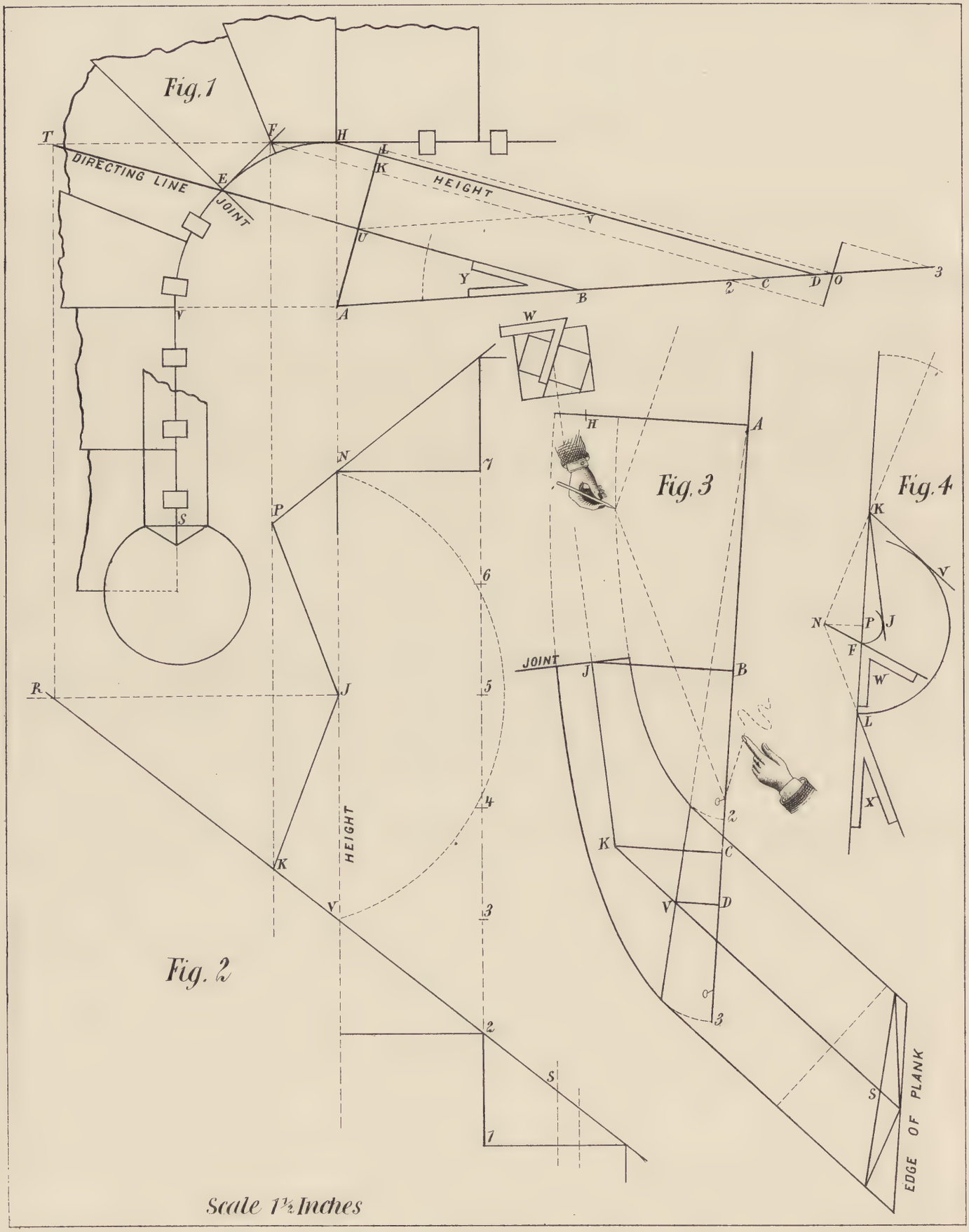
Fig. 1
DIRECTING LINE
JOINT
HEIGHT
Fig. 2
HEIGHT
Fig. 3
JOINT
Fig. 4
EDGE OF PLANK
Scale 1½ Inches

Plate 25.

THE WREATH IN TWO PIECES, ONE OF WHICH FORMS A DOUBLE RAMP.

Figure 1 shows the plan of stairs starting from a newel, having two square steps below, four winders in the quarter circle, and square steps above. The wreath to be in two pieces. The upper one forming its own ramp, and its straight wood thrown on the same pitch as rake rail over square steps. The lower piece to have sufficient straight wood, to stand over the two square steps at the starting, and form the easing and mitre at the cap. To do this; divide the quarter circle into two equal parts as E. Through E and H draw tangents meeting in point F. The number of risers shown on plan is eight. The quarter circle is centre line of rail.

Now proceed, by making an elevation showing the pitches and height of wreath. This is done by dropping perpendiculars from F and H; that on the right represents spring line. From this line on lower part of plate, make the elevation of the two square steps starting. Now set off the number of risers same as on plan, and make the elevation of square step above. Draw lower pitch through corners of steps, cutting the perpendiculars at V and K, draw the upper pitch cutting through N and P. This gives the whole height of wreath on spring as V N, which divide in J. Join P J and K J. This shows both pieces of wreath having equal pitches. Find the pitch of plank, by squaring over from J cutting at R. Extend tangent H F on plan to the left. Make H T equal J R on elevation. Draw from T through E, draw from F and H parallel with T E. Now draw from centre A square with T E. Make height K V equal height V J on elevation. Join V U. Draw from A parallel with U V cutting through D. This is pitch of plank.

Find half long diameter of semi-ellipse, by making A L equal A H. Square up from L cutting at O, and on each side of O set off half width of rail. This gives A 2 as half diameter for inside curve on mould, and A 3 for outside curve. To find the mould: Lay a rod on the pitch and mark the points A B C D. Upon the face of a board, as shown at Fig. 3, draw a line for long diameter. Mark points A B C D from the rod, and square them over. Make B J, C K, and D V, equal U E, K F, and L H, Fig. 1. Draw from K through J and V. These are tangents on the mould, and to be correct must equal pitches V K J, Fig. 2. Make A H equal radius on plan, set half width of rail on each side of H. Find points for pins, and strike the curves on mould. Draw from A through V. Add straight wood parallel with tangent K V. Make V S equal V S on pitch.

Fig. 2. Here observe that the line from the step giving point S, represents line S through mitre cap, on plan; both stand in the same position from riser, and to the right of S on the pitch is shown length of mitre. This transfer to tangent from S on mould, and draw parallel with long diameter. To find the mitre on surface of plank: Draw through S parallel with A V, join the points and the form is shown. The pitch at Fig. 1 shows bevel Y. This is applied to the square edge of plank, and gives the mitre point on wreath. The straight wood on upper piece of wreath may be any length, as dotted line across the mould shows. The bevel for this and centre joint is found as follows:

Fig. 4. From any point on a line parallel with long diameter, as K, draw K V and K J parallel with tangents on mould. Transfer pitch of plank as follows: From B, Fig. 1, as centre, and with any radius draw dotted arc. With same radius and K for centre, draw an arc of equal length. From its upper corner draw the pitch through K. Square over from any point, as P, cutting the pitch at N. With P for centre, and a radius touching K V, strike an arc cutting at L, draw from N through L. This gives bevel X for joint on straight wood of upper piece of wreath. With same centre, and a radius touching K J, strike an arc cutting at F, draw from N through F. This gives bevel W for centre joint J for both pieces of wreath.

Plate 26.

THE WREATH STANDING OVER CURVES OF UNEQUAL RADIUS.

In this case the rail starts from the newel with a curve, which is the only difference from the plan of preceding plate. But these stairs, starting in the manner stated, presents a more finished and better effect than the former. The wreath as usual to be in two pieces. The upper forming its own ramp. The lower forms mitre and easing at the cap, and makes two unequal pitches from the newel. The number of risers shown on plan is eight, or counting from top of first step, seven.

To prevent the ramp on upper piece of wreath from being too high. Let the two upper tangents on plan be short. To do this, fix a joint say at H, Then through H and from E, draw tangents. These lines intersect at points F and J; making H J and J 7 equal; and E F and F H unequal. The length of tangents are now given, and by unfolding three of them, as E F, F H and J 7, the pitches of wreath are obtained, as shown at Fig. 2, by perpendiculars passing through points 7 J and F E. That through 7 represents the spring line, and on which set off the number of risers from top of first step to equal those on plan. Then draw the upper pitch, cutting through 7 and J. From J as a fixed point, draw say through point F; and from F draw the pitch starting from mitre cap, as F E. The pitches of wreath being given, find the heights by drawing from E, cutting at L. This gives L H for height of lower piece of wreath. Height of upper piece being H 7, Find a direction for pitch of plank by squaring over from H, cutting at N; transfer H N to upper tangent on plan, making 7 N equal it; draw from N through H; draw from J and 7 parallel with N H. From any point as A, square over A 2; make height A B equal height H 7, Fig. 2; join B C. This is pitch of plank for upper piece of wreath. From points of intersection, as C, P, B, Draw square with the pitch.

Make B H, P J, and C 7 equal A H, 2 J, and C 7 on the left; Draw from J through 7 and H. These are tangents on the mould, and to be correct must equal pitches 7 J H, Fig. 2. Find the junction of straight wood, by making B R equal A R; draw from R through 7. Now draw any number of lines from the plan parallel with N H, cutting the pitch; and from intersections thus given, draw square with B C. Transfer measurements from the plan, by which points are given to trace the curves on mould.

Fig. 5. To find joint bevels: From any point on a line parallel with the pitch, as K, draw K J and K H parallel with tangents on mould. Transfer pitch of plank as follows: From B, Fig. 4, as centre, and with any radius, draw dotted arc. With same radius and K for centre, draw an arc of equal length. From its upper corner, draw the pitch through K; square over from any point, as 2, cutting the pitch at O. With 2 as centre, and a radius touching K J, strike an arc, cutting at 6; join 6 O. This gives bevel X for joint on straight wood of upper piece of wreath. With same centre, and a radius touching K H, strike an arc, cutting at a point on the right of 2; through which draw from O. This gives bevel W for joint H.

To find the mould for lower piece of wreath: Make H L, Fig. 1, equal L K, Fig. 2; Draw from L through E; draw from F and H parallel with L E. From any point, as P, draw P V square with L E. Make height P H equal height L H, Fig. 2; draw from V through H. This is pitch of plank. Draw from points V Y H, square with pitch. Make V E, Y F, and H H, Fig. 3, equal V E, 2 F, and P H, Fig. 1; draw from F, through E and H. These are tangents on the mould, and to be correct must equal pitches E F H, Fig. 2. Set off length of mitre from E on tangent to equal that shown on pitch to the right of E, Fig. 2. Make 3 T equal T S; draw from T through E; again draw through mitre point, parallel with the pitch. This line represents end of mould and the square edge of plank. Both are fair on the application of mould. The bevel Z, shown in angle of pitch, gives mitre point on edge of plank. Find curves on mould, by drawing any number of lines through width of rail on plan parallel with L E, and cutting the pitch. From points thus given, draw square with pitch. Transfer measurements from the plan, and through these points trace curves on mould.

Make joint H square with H F. To find a bevel for this, draw from angle of pitch H parallel with tangent H F on mould. Extend T 3, giving a point on line P H. With 3 as centre, and a radius touching S H, strike an arc, cutting on the right of 3, through which point draw from point on line P H. This gives bevel W for joint H. Moulds and bevels for both pieces of wreath are now complete.

Plate 26

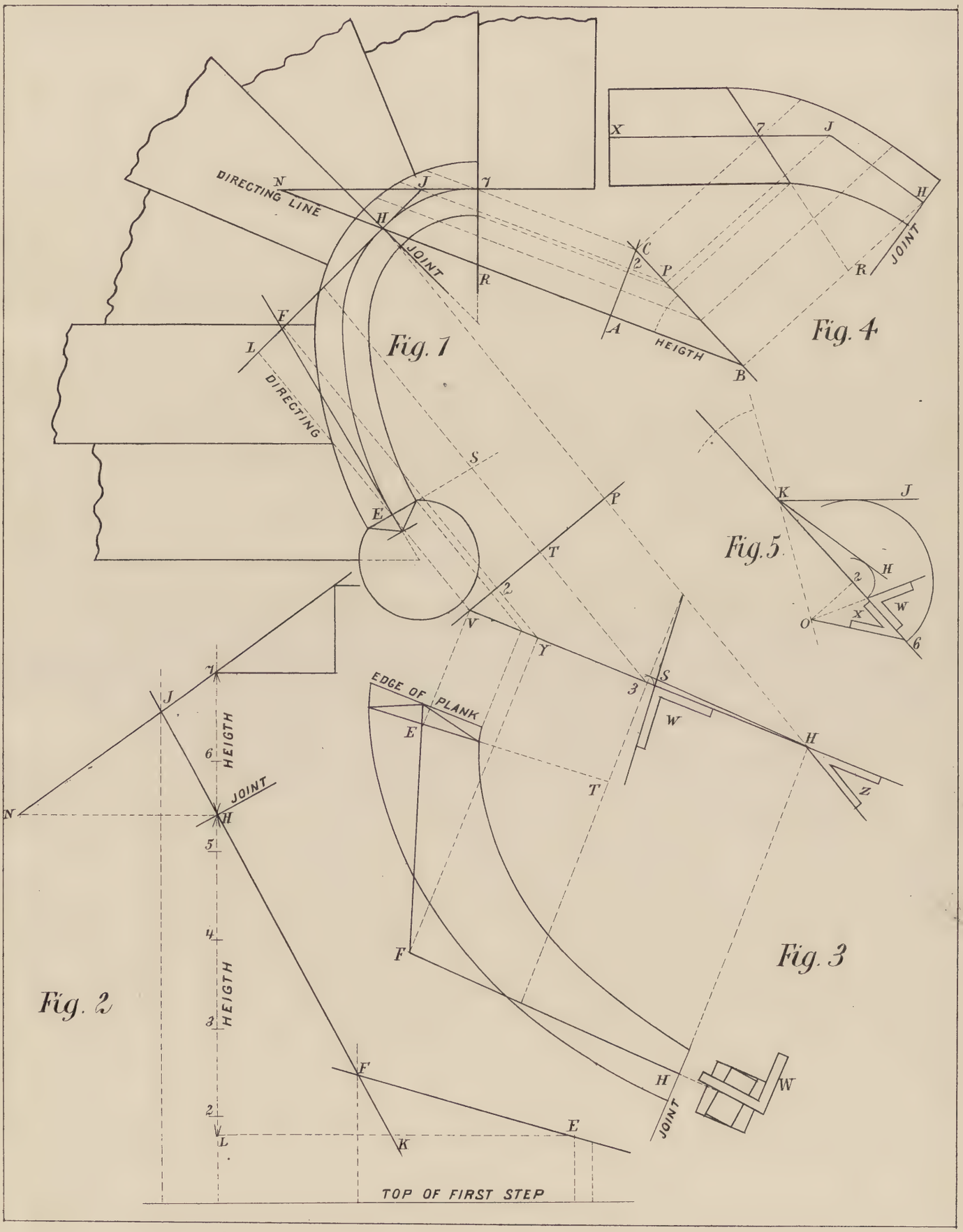

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

EPA
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Plate 27

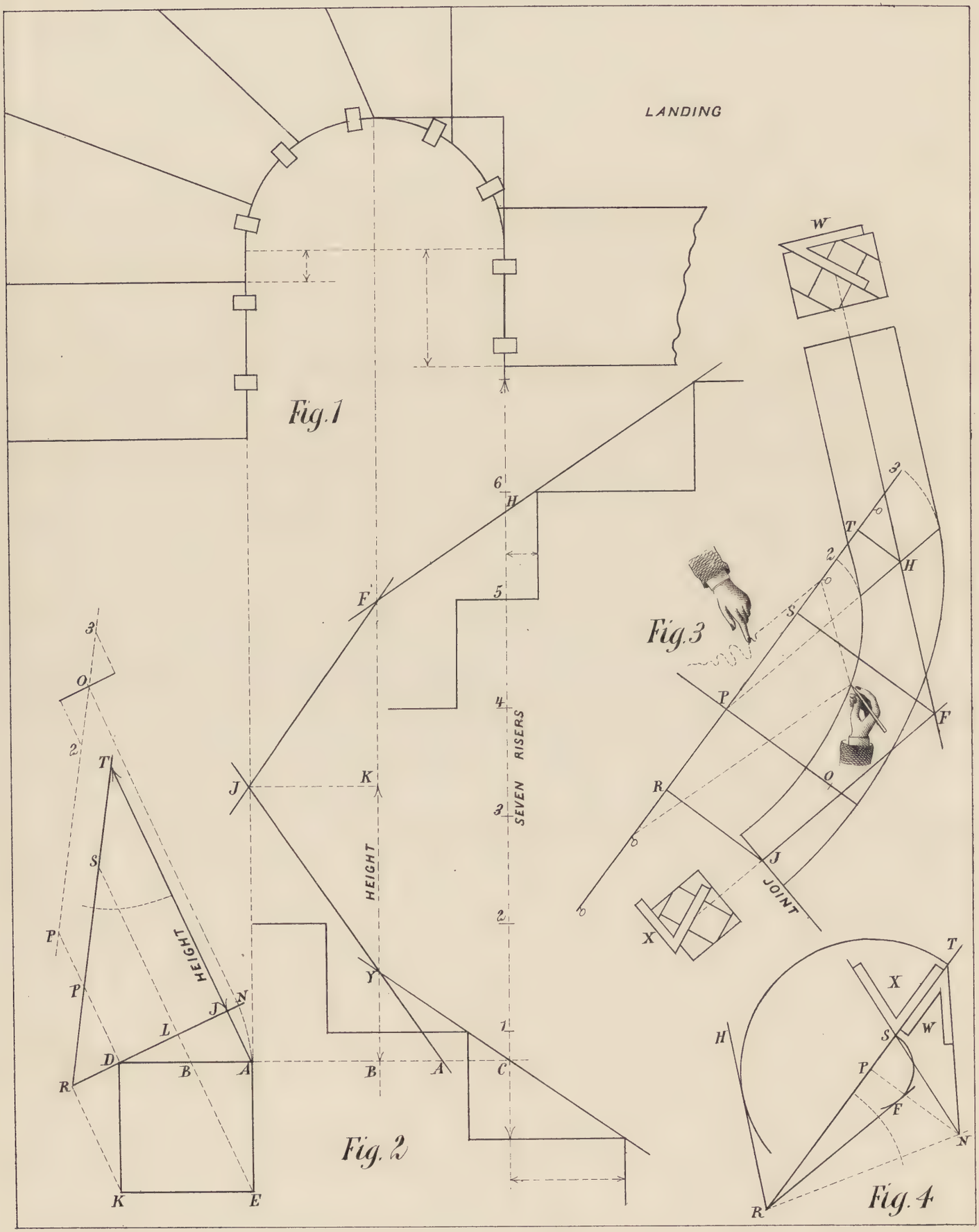
LANDING
Fig. 1
6
H
F
5
4
SEVEN RISERS
3
2
1
J
K
HEIGHT
Y
B
A
C
Fig. 2
3
O
2
T
S
P
P
HEIGHT
J
N
L
D
B
A
R
K
E
W
3
T
2
H
S
P
F
R
O
J
JOINT
X
Fig. 3
T
X
H
S
W
P
F
N
R
Fig. 4

Plate 27.

THE WREATH OVER SQUARE STEPS, WINDERS, AND QUARTER LANDING.

Figure 1 shows a ground-plan of stairs, the wreath having a joint opposite half the diameter of semi-circle. Each piece of wreath to form its own ramp, and have straight wood thrown on the same pitch as rake rail over square steps. The number of risers shown in plan is eight. The position of risers from spring line indicated by arrows. The dotted perpendicular on the right represent the spring line; on which set off the same number of risers as on plan. Draw the elevation of square step above and below, to stand in same position as those on plan. The projection of risers from spring line shown by arrows the same as on plan.

Proceed by drawing lower pitch through corners of square steps, cutting perpendiculars at points C and Y. Draw the upper pitch cutting through H and F. Divide Y F in K; square over from K; cutting in J; join F J; draw from J through Y. This gives C Y J as pitches for one-half of wreath. To find its height, square over from C to the left; this gives B K as height. To draw the mould, form a square as that shown, its sides being equal to radius of plan. Make the distance A B equal A B on the right. Draw from E through B; draw from K D A parallel with E B; again draw through D square with E B. Make height J T equal height B K on the right; join T R. This is pitch of plank. Find half long diameter by drawing any line as P O parallel with pitch. Make D N equal D A. Square up from N cutting at O; and on each side of O set half width of rail. This gives P 2 for inside curve on mould, and P 3 for outside curve. Proceed by laying a rod on the pitch. Mark the points R P S T; have a board as shown in Fig. 3, and draw a line for long diameter. Then by the rod mark the points R P S T; square these over, and make R J, S F, and T H, equal R K, L E, and J A, Fig. 2. Draw from F through H and J. These are tangents on the mould, and to be correct must equal pitches C Y J, Fig. 2. Make P O equal radius on plan, and on each side of O, set half width of rail; draw from P through H. Find points for pins, and strike the curves on mould. Add straight wood parallel with H F. Make the joint through J square with J F.

Fig. 4 show joint bevels, which are found as follows: From any point on a line parallel with long diameter, as R; draw R H and R F parallel with tangents on mould. Transfer pitch of plank, by taking T, Fig. 2, for centre, and with any radius, draw dotted arc. With same radius, and R for centre, draw an arc of equal length. Through its lower corner and R draw the pitch; Square over from any point, as P, cutting the pitch at N, with P as centre, and a radius touching R H; strike an arc cutting at T; join T N. This gives bevel W for joint on straight wood. With same centre, and a radius touching R F, strike an arc cutting at S; draw from N through S. This gives bevel X for centre joints of both pieces of wreath. The square sections of plank and rail show the application of these bevels to the joints.

It will be noticed, that in making the upper part of this wreath form its own ramp, that the rake rail over square steps has to run into the cylinder, and terminate at point F. But by doing so the elevation shows at a glance, that the wreath over the upper winder stands too high; whilst the lower part of wreath having the same pitches as the upper, its height is perfectly correct. This method of forming a wreath being the most simple, it is the most often adopted, for, by means of it, the trouble of working a ramp on the straight rail is avoided, which is always desirable where it can be done, and at the same time have the heights uniform. This wreath when finished would certainly present to the eye the best possible effect, and its height everywhere regular, except the point just mentioned; and this alone is sufficient to condemn and make it objectionable. The motive in giving this drawing is to assist and instruct the learner, by pointing out such errors and defects in a construction as might possibly escape the notice of even practical men. Then by turning to the following plate, show a more approved method for producing a similar wreath.

Plate 28.

SECOND EXAMPLE OF A WREATH OVER SQUARE STEPS, WINDERS AND QUARTER LANDING.

Figure 1 shows a plan similar to the preceding—the risers here being placed in such a position as to give the wreath a regular and uniform height throughout. To do this let a riser stand on the spring line as shown on the left, and make tangents 2 3 and 3 4 each to equal half a square step. This at once fixes a joint at 4, and from which draw riser starting from the landing. With half a square step in the compasses, set off from 4 the number of winders on centre line of rail. Extend tangent 3, 4, cutting at 5. This gives 4, 5, 6 as tangents for upper piece of wreath, and 2, 3, 4 for the lower piece. To find height and pitches of this wreath, let tangents, winders, and square steps be unfolded on a narrow board, and in the same manner as laying out a string. This is shown at

Fig. 2. Here the dotted perpendiculars passing through points 2, 3, 4, 5, 6 show the tangents of plan unfolded—the square steps, landing, and winders being in the same position as those on the plan. Draw the lower pitch, cutting perpendicular at 5. Next draw the upper pitch of square step. Take any point on this pitch that will form an easy ramp, as K. Draw from K through 5. This determines pitches for upper piece of wreath, as 4, 5, 6. To find its height, Draw from points 4 and 6 parallel with steps, cutting perpendicular through 5. This gives D N for the height. Extend pitch 6, 5, cutting at F. This gives the distance, F D, which transfer to tangent on plan, making 5 F equal it; Draw from F through 4; draw from 5 and 6 parallel with F 4; again draw through centre O square with F 4; make height P N equal height D N, Fig. 2; join N J. This is pitch of plank. Find half long diameter of semi-ellipse by drawing any line parallel with the pitch; Make O V equal radius O 6; square up from V, cutting at O; on each side of it set off half width of rail. This gives L 2 for inside curve on mould, and L 3 for outside curve.

To find the mould, lay the edge of a board on the pitch, and mark the points J K L N; these square over as shown at Fig. 3; Make N 6, K 5, and J 4 equal P 6, C 5, and J 4 on plan; draw from 5 through 4 and 6. These are tangents on the mould, and to be correct must equal pitches 4, 5, 6 on elevation; make L C equal radius on plan; set half width of rail on each side of C; draw from L through 6. Now find points for pins, and strike the curves on mould; make the joints square with tangents.

Fig. 4 shows bevels for joints, and are found as follows: From any point, as N on a line parallel with long diameter, Draw N 4 and N 6 parallel with tangents on mould; transfer pitch from Fig. 1; Take N as centre, and with any radius draw dotted arc; with same radius, and N, Fig. 4, for centre, draw an arc of equal length; from its lower corner draw the pitch through N; Square over from any point, as Y, cutting the pitch at R; with Y as centre and a radius touching 4 N, strike an arc, cutting at P; join P R. This gives bevel W for joint 4. With same centre and a radius touching N 6, strike an arc, cutting at V; join V R. This gives bevel X for joint on straight wood of wreath. The application of bevels shown by square sections of plank.

To find the mould for lower wreath piece: This could be done on the plan, but in order to avoid confusion, let the centre line of rail be given at any convenient place, as Fig. 5. Here draw tangents A B C to equal 2 3 4 on plan; make height T V equal height B 3 on elevation, Fig. 2; draw from H through V. This is pitch of plank. Find half diameter by squaring up from R, cutting the pitch at P. Set half width of rail on each side of P. This gives V 2 as half diameter for inside curve on mould, and V 3 for outside curve. To draw the mould: From the edge of a board square over a line, as V 3, Fig. 6; Make V P and V 4 equal H V, Fig. 5; square over the lines; make V 3, 4, 2 and P 4 equal T B and H A, Fig. 5; draw from 3 through 2 and 4. These are tangents on the mould, and to be correct must equal pitches 2, 3, 4 on elevation, Fig. 2; make V O equal radius on plan; set half width of rail on each side of O; draw from V through 2; Now find points for pins, and strike the curves on mould; add straight wood parallel with 2 3; make the joints square with tangents.

The tangents on this piece of wreath being of equal lengths, and having equal pitches, therefore one bevel answers for both joints. To find it, draw P J parallel with tangent 3, 2 on mould; Transfer pitch of plank from Fig. 5 by taking P as centre, and with any radius draw the dotted arc; with same radius return to Fig. 6, and from P as centre draw an arc of equal length, and from its upper corner draw the pitch through P, cutting at K; With V as centre and a radius touching P J, strike an arc, cutting at L; draw from K through L. This gives bevel X for both joints.

It is now very evident by the elevation that this wreath is decidedly superior to the preceding. Here the lengths of short balusters are equal on square steps and winders, the pitches, heights and curves regular. We have already stated that the tangents for any wreath can be unfolded on a narrow board, and we may add, that the best tool for this purpose is a framing square, having a fence fastened on its blades to slide along the edge of a board when laying out the work.

Plate 28

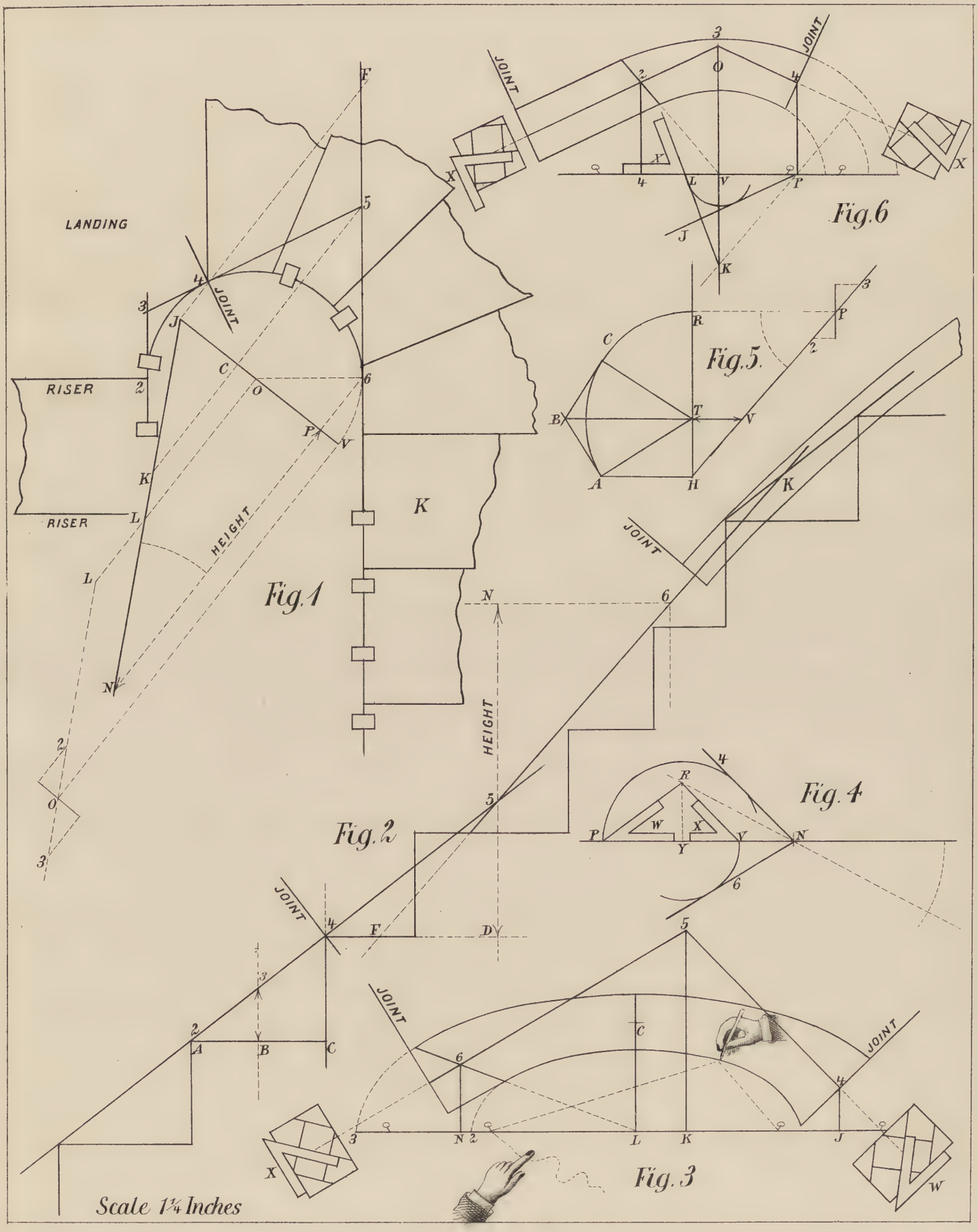
LANDING
RISER
RISER
HEIGHT
JOINT
Fig. 1
Fig. 2
Fig. 3
Fig. 4
Fig. 5.
Fig. 6
Scale 1¼ Inches

Plate 29

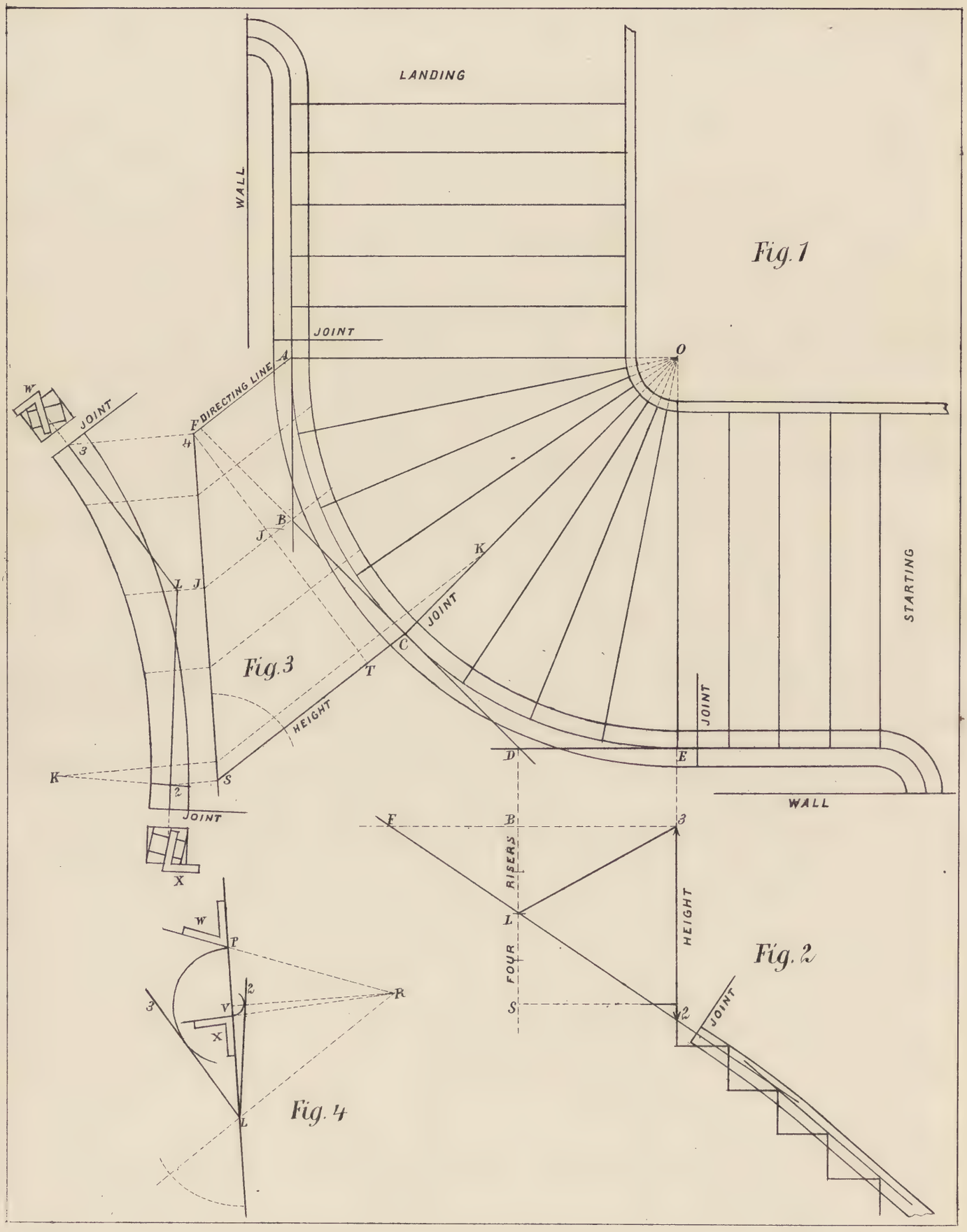
LANDING
WALL
JOINT
DIRECTING LINE
STARTING
WALL
JOINT
JOINT
JOINT
JOINT
HEIGHT
Fig. 1
Fig. 3
Fig. 2
Fig. 4
FOUR RISERS
HEIGHT
A
B
C
D
E
F
J
K
L
O
S
T
W
X

PLATE 29.

THE SIDE RAIL, ALONG STRAIGHT WALLS, AND AROUND A QUARTER-CIRCLE.

FIGURE 1 shows the plan of stairs where it is required to have a side rail. The centre line of rail in the quarter-circle is divided into two equal parts as point C. Through this draw a tangent intersecting those from A and E in the points B and D. The wreath to be in two pieces. The rake rail over square steps above and below, must have a ramp to meet the wreath as it stands on a different pitch, owing to the winders along the wall being wider than square steps. This will be better understood by making the elevation of two or three square steps as shown at Fig. 2. Here drop perpendiculars from D and E; take any point as S, and square over S 2; make S B equal the height of four risers, this being the same number as from E to joint C on plan; draw through B parallel with S 2; divide S B in L.

Now make the elevation of a few square steps and risers from point 2, and through corners of steps draw the pitch. Take any point as third riser on the right of 2, and draw from it, cutting through L and extended line 3 B. This gives the height of each piece of wreath as 2, 3, and its pitches 2 L 3. We have also the distance B F as direction of a line for pitch of plank. Extend tangent C B to the left; Make B F equal B F on elevation; Draw from A through F; draw from B and C parallel with A F. Take any point as T; draw T 4 square with A F; make height T S equal height 2, 3 on elevation; join S 4. This is pitch of plank.

Draw square with the pitch from points S J 4; Make 4, 3 equal F A, and J L equal J B; make S 2 equal T C; draw from L through 2 and 3. These are tangents on the mould, and to be correct must equal pitches 2 L 3, Fig. 2.

Draw any number of lines through width of rail on plan, cutting the pitch. From intersections thus given, draw square with the pitch. Now find points and trace the curves on mould. The straight wood projecting from 2, make it equal the space between the joint on ramp, and 2, shown on elevation.

Fig. 4 shows joint bevels, and are found as follows: From any point as L on a line parallel with pitch of plank, Draw L 3 and L 2 parallel with tangents on mould; Transfer pitch of plank from Fig. 3, by taking S as centre, and with any radius, draw the dotted arc; with same radius and L for centre, draw an arc of equal length, and from its upper corner, draw the pitch through L; Square over from any point as V, cutting the pitch at R; with V for centre, and a radius touching L 3; strike an arc cutting at P; draw from R through P. This gives bevel W for centre joint of wreath. With same centre and a radius touching L 2, strike an arc cutting a point below V; draw from R through the point. This gives bevel X for joint on straight wood. The square sections of plank show the application of both bevels.

PLATE 30.

THE WREATH OVER FIVE WINDERS.

FIGURE 1 shows stairs where the risers are placed in the most awkward position imaginable, which is no unusual thing where the work is intrusted to those who have no practical knowledge in such matters. Bad and indifferent as the plan undoubtedly is, there is no difficulty in producing a wreath to stand correctly over it. In making the elevation it will be noticed that two moulds are required, as the lower piece of wreath can be made to form its own ramp, and have straight wood thrown on the same pitch as the rake rail over square steps; but the upper piece of wreath will have to connect with a ramp worked on straight rail.

Fig. 2 shows the elevation of eight risers, being the same number as on plan. The perpendicular passing through 2 and 6 represent the spring line. The riser of square step stands on this line and is in the same position as that on plan. The riser above projects from spring line as indicated by an arrow, the same as on plan. Now proceed by drawing the lower pitch, cutting through 2 and 3; draw the upper pitch through corners of square steps. Take any point on this pitch that will form an easy ramp; assume for this the line cutting through 6 and 5; divide 3, 5 equally in V; square over from V, cutting at 4; draw from 4 through 3 and 5. This gives 2, 3, 4 as pitches for lower piece of wreath, and 4, 5, 6, for upper piece.

To find height and pitch of plank for lower piece of wreath, square over from 2, cutting through N and P. This gives P 4 as height. Form the square as shown, its sides being equal to radius of plan; extend 4 3, cutting at J; Draw from J through S; draw from N P E parallel with J S. Again draw through E, square with J S; make height H A equal height P 4; draw from A through D. This gives pitch of plank. Find half long diameter by making E F equal E S; set half width of rail on each side of F. This gives B 7 for inside curve on mould and B 8 for outside curve.

To find joint bevels, make N 4 on the right equal N 3 on the left; draw from V through N; take P as centre and a radius touching V N; strike an arc, cutting at R; join R E. This gives bevel Z for joint on straight wood of wreath. Take N as centre, and a radius touching J 3; strike an arc, cutting at Y; draw from S through Y. This gives bevel X for centre joint of lower piece of wreath.

Now proceed and find the mould. Lay a rod on the pitch and mark the points A B C D. Have a board, as shown at Fig. 3, and draw a line for long diameter; mark on it from the rod, points A B C D; these square over, and make A 4, C 3, and D 2 equal H P, K N, and D S, Fig. 5; draw from 3 through 2 and 4. These are tangents on the mould, and to be correct must equal pitches 2, 3, 4, on elevation. Make B O equal radius on plan; set half width of rail on each side of O; draw from B through 2. Now find points for pins and strike the curves; add straight wood parallel with tangent 3 2. This completes the mould for lower piece of wreath. The square sections of plank show application of bevels to joints.

To find height and pitch of plank for upper piece of wreath: square over a line from 6, cutting through K and R. This gives R 4 as height. Form a square as shown. Extend 4, 5, cutting at J; draw from J through S; draw from K R E parallel with J S. Again draw through E, square with J S; make height H D equal height R 4; draw from A through D. This is pitch of plank. To find half of long diameter, make E F equal E S, square up from F cutting at 8; set half width of rail on each side of 8. This gives C 2 as half long diameter for inside curve on mould; and C 3, for outside curve.

To find joint bevels make 4 K on the right equal 5 K on the left; draw from V through K; take R as centre and a radius touching V K; strike an arc cutting at O; join O E. This gives bevel W for upper joint of wreath on straight wood; take K as centre, and a radius touching 5 J; strike an arc cutting at Y; join Y S. This gives bevel X for centre joint of wreath. Now proceed with the mould. Lay the edge of a board on the pitch, and mark the points A B C D; square these over as shown at Fig. 4. Make A 4, C 5, and D 6 equal H R, N K, and A S, Fig. 1. Draw from 5 through 4 and 6. These are tangents on the mould, and to be correct must equal the pitches 4, 5, 6 on elevation. Make B O equal radius on plan; set half width of rail on each side of O; draw from B through 6. Now find points for pins and strike the curves; make the joints square with tangents. This completes the mould for upper piece of wreath. The square sections of plank show application of bevels to joints.

Plate 30

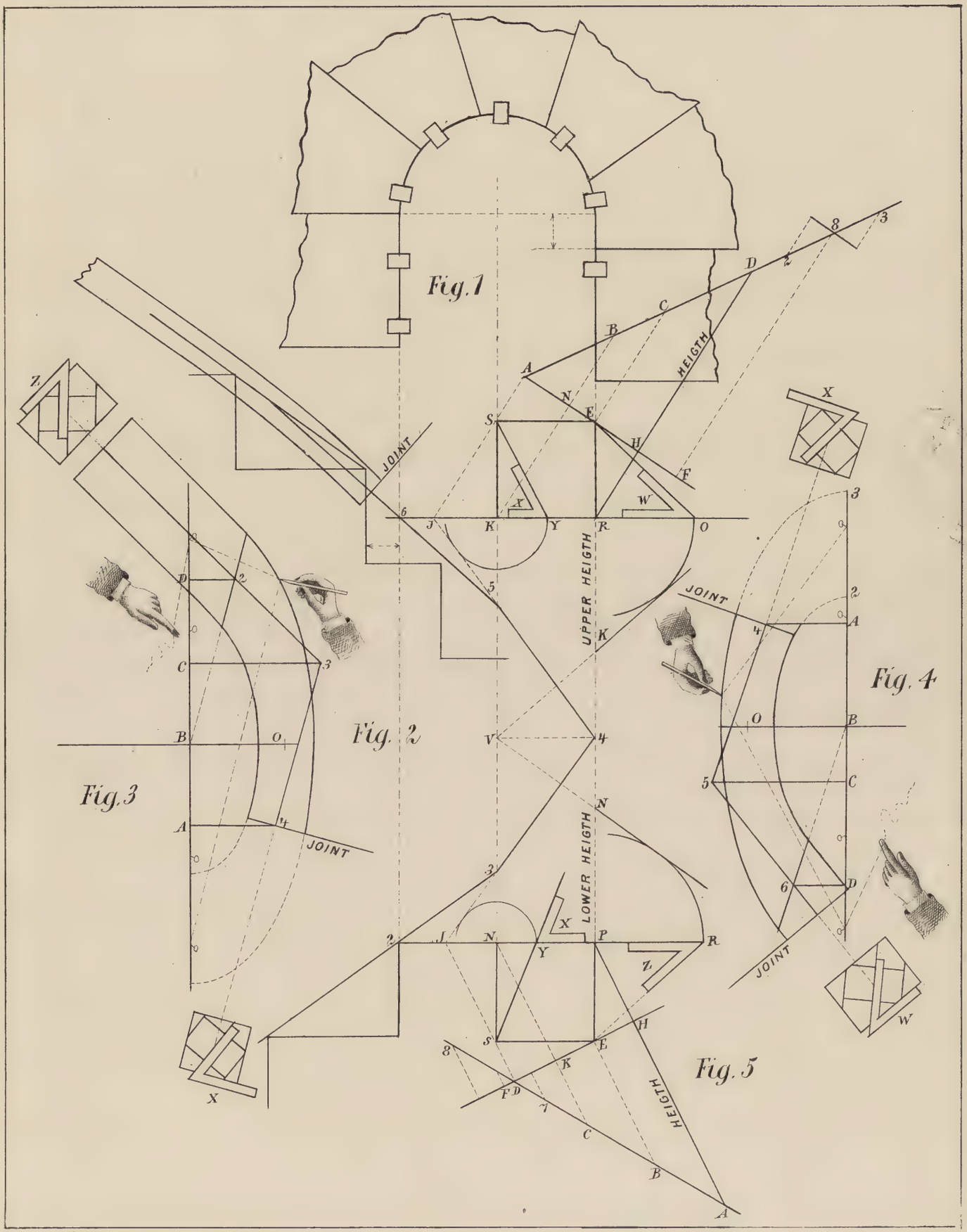
Fig. 1
HEIGTH
JOINT
UPPER HEIGTH
LOWER HEIGTH
Fig. 2
Fig. 3
Fig. 4
Fig. 5

Plate 31

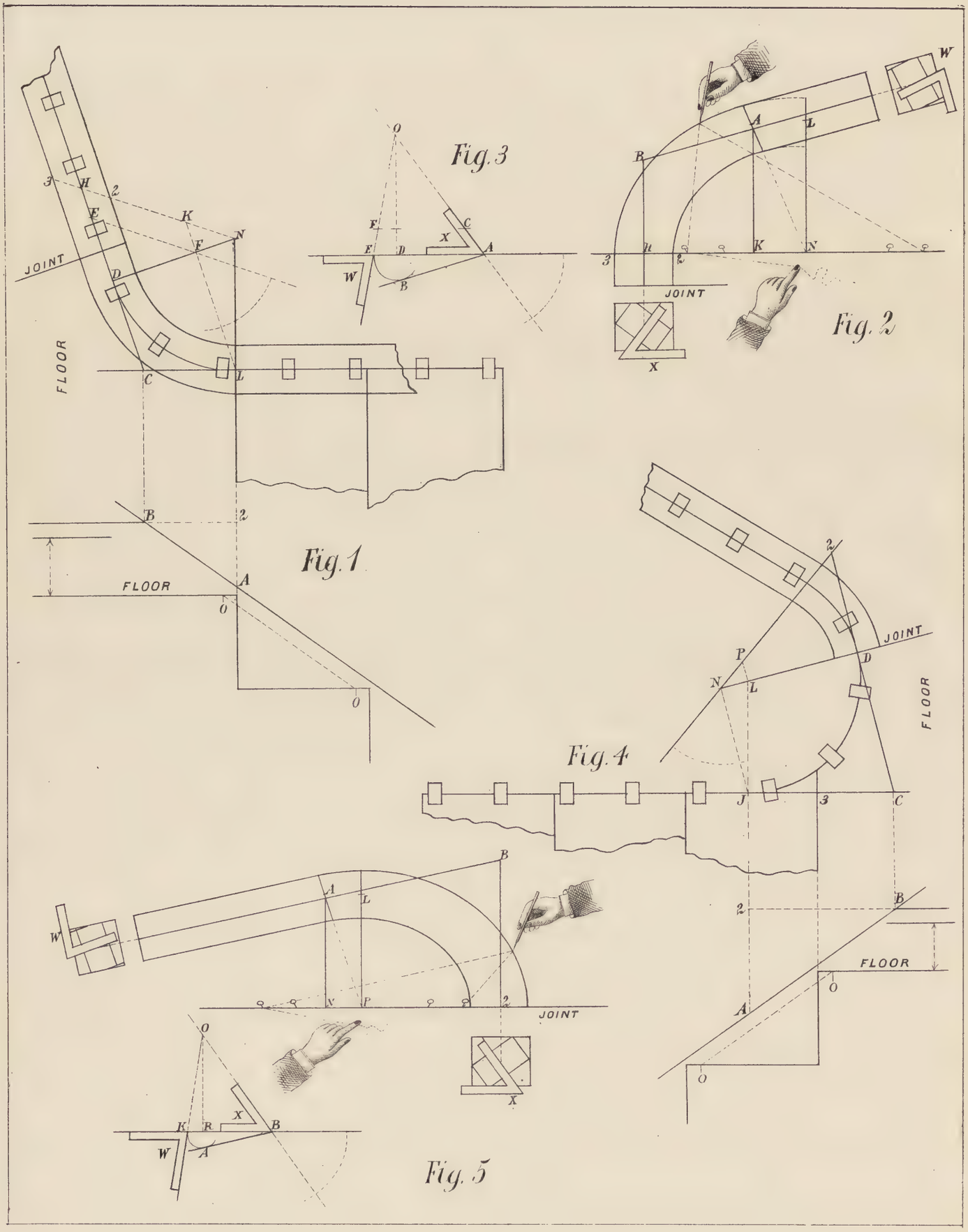
JOINT
FLOOR
Fig. 3
Fig. 2
Fig. 1
FLOOR
JOINT
FLOOR
Fig. 4
JOINT
FLOOR
Fig. 5

Plate 31.

LANDING WREATHS FOR STAIRS, WHICH FORM ACUTE AND OBTUSE ANGLES.

It sometimes happens that for some particular purpose the landing of stairs is thrown out of square. When such is the case, the wreaths must be either more or less than a quarter circle. Here both positions are given, and the manner in which the wreaths are produced.

Fig. 1 shows a plan where the landing makes an obtuse angle with the stairs, and gives a curve less than a quarter circle. The face of riser landing stands on the spring line. The tangents through centre of rail meet in point C. But before going further it may be well to state that the proper way to proceed in fixing the position of riser landing is to drop a perpendicular from C, and then from any point, as B, draw the pitch of a square step. This makes B a point in half the thickness of both rake and level rail. Then the floor line should stand below B, equal to half a riser and half thickness of rail. This at once determines position of riser landing. To neglect this method is almost certain to have the level either too high or too low for long balusters on square steps, as it is usual to make these answer for the landing. But the plan before us explains the point. Here the riser stands on spring line, which is not the proper position for throwing the level rail to just half a riser above the floor, as the arrow shows a greater space. It has, however, been done in order to show the difference between a correct and incorrect method for the position of a riser landing.

We now proceed to find pitch of plank and height of this wreath, by squaring over from B, cutting at 2. This gives A 2 as height; Draw from L parallel with tangent C D; make height D E equal height A 2; draw from E through F; draw from centre N parallel with E F, cutting through H. This is pitch of plank, and the points N 2 gives half the long diameter for inside curve on mould, and N 3 gives the outside curve. Lay a rod on the pitch, and mark the points N K H; have a board as shown at Fig. 2, and draw a line for long diameter; lay on the rod, and mark from it the points N K H; these square over, and make K A and H B equal F L and D C, Fig. 1; draw from B through A. This is tangent on the mould, and to be correct must equal pitch A B, Fig. 1. The tangent B H when in position falls level, and stands over C D on plan; make N L equal radius on plan; set half width of rail on each side of L; Draw from N through A. Now find points for pins and strike the curves; draw the straight wood parallel with B A, and add three or four inches of straight wood below H. This completes the mould.

Fig. 3. To find joint bevels, From any point, as A on a line parallel with long diameter, draw A B parallel with tangent B A on mould. Transfer pitch of plank from the plan as follows: Take F as centre, and with any radius, draw the dotted arc; with same radius, and A as centre, draw an arc of equal length, and from its lower corner draw the pitch through A. This gives bevel X for upper joint on wreath; Square over from any point, as D, cutting the pitch at O; with D as centre, and a radius touching A B, strike an arc, cutting at E; draw from O through E. This gives bevel W for lower joint. It has already been shown that the exact width of any mould can be given by having the bevels for joints, and by the following method: From the edge of a board draw the bevel lines E O and A O; run a gauge line to half the width of rail, cutting at points F and C. This gives A C as half width of mould across its wide end; and E F gives half the width across the narrow end. The square sections of plank show the application of bevels to joints.

Fig. 4. Here the stairs and landing form an acute or sharp angle. The curve for centre line of rail may be any radius, as J L, touching both sides of the angle. The object now to determine is the exact position of a riser on the plan, in order to have the level rail stand a proper height above the floor. Let the wreath be in two pieces having a joint on any part of the curve, as D, through which draw a line square with D L, cutting in C; square down from J and C; Take any point, as B on line from C; Draw from B the pitch of a square step; then from point B set off half a riser and half thickness of rail, and draw the floor; set off from the pitch half thickness of rail, intersecting the floor. This fixes O as the centre of a short baluster, on which under side of rail rests, and gives a clear direction to draw face of riser, as shown; Extend this, cutting through tangent at 3, and we have the exact position of riser on plan, which will cause under side of level rail on landing to stand half a riser above a short baluster; or make it the proper height for long balusters on square steps. The same rule may be applied to all similar positions.

To find the height and pitch of plank for the wreath, Square over from B, cutting at 2. This gives A 2 as height; Draw from J parallel with C D, cutting line through D L at N; make height D 2 equal height A 2; draw from 2 through N. This is pitch of plank. Draw from centre L parallel with C D, cutting at P. This gives P 2 as half long diameter in centre of mould. Lay the edge of a board on the pitch, and mark the points 2, P N; these square over as shown at Fig. 5; make 2 B and N A equal C D and J N on plan; draw from B through A. This is tangent on the mould, and to be correct must equal pitch A B on the right. The tangent 2 B when in position falls level and stands over C D on plan. Draw from P through A; make P L equal radius on plan; set half width of rail on each side of L. Now find points for pins, and strike the curves; add the straight wood parallel with tangent B A. This completes the mould for the wreath.

To find joint bevels: From any point, as B on a line parallel with long diameter, draw B A parallel with tangent A B on mould; Transfer pitch of plank from Fig. 4; Take N as centre, and with any radius draw the dotted arc; With same radius and B for centre draw an arc of equal length, and from its lower corner draw the pitch through B. This gives bevel X for joint on upper part of wreath. From any point, as R, square over a line, cutting the pitch in O; with R as centre, and a radius touching A B, strike an arc, cutting at K; draw from O through K. This gives bevel W for joint on straight wood. The square sections of plank show application of bevels to joints; The mould for level piece shown on plan, its curves are struck from centre L.

Plate 32.

WREATHS FOR CIRCULAR STAIRS.

Figure 1 shows the ground-plan. The construction here presents no difficulty whatever. The same system being adopted throughout, and by the same means, every form of wreath is produced, and with equal simplicity, regardless of situation or plan of stairs. The only points here that need most attention, are the starting and landing wreaths, and these are regulated by having the pitch of a single piece of wreath standing over a given number of risers as five or six, the joints on plan being arranged in such a manner as to make one mould answer for two, three, or more pieces. The steps on centre line of rail are equally divided. It has been shown that all joints are square with the surface of plank, and all tangents across joints must be on the same pitch, and that a plank can be thrown on two different pitches, and by means of this, any piece of wreath can be made to form its own ramp, and by the same rule we proceed to find the wreaths for these stairs.

Let the joints for one piece of wreath be fixed at any two points, as A C on centre of rail; draw tangents through A and C intersecting in point B; draw the chord A C; this divide into two equal parts as T; draw from T through B; draw from A parallel with T B; make A N equal T B; draw from N through B; make B D equal the height of three risers; draw from D through N. This is pitch of plank. Make N D on the right and left equal; draw from N square with the pitch; make N S equal T B; draw from D D through S. These are tangents on the mould. Divide A T into exact and equal parts as four; these square over, cutting through width of rail; Now divide the pitch between N D on right and left, each into four equal parts; and from points thus given, draw square with the pitch; make N 2 equal T 2; set off from 2 the width of rail the same as on plan; transfer measurement from point 4 on plan, to lines square with the pitch on each side of N S; take the next measure on the left of 4; transfer it in like manner; Work from the right and left of line N S, until the required number of points are given, and through which trace the curves on mould by bending a thin lath. But to be more exact in having the width of mould across each joint, Find the bevel for joints as shown at Fig. 3; Draw any line parallel with the pitch; Extend tangent D S, cutting at T; Transfer pitch of plank, by taking D as centre, and with any radius, draw the dotted arc; with same radius, and T for centre, draw an arc of equal length, and from its lower corner, draw the pitch through T; From any point as L, square over a line cutting the pitch in O; Take L for centre, and a radius touching T S; strike an arc cutting at V; join O V. This gives bevel X for both joints on the wreath. Set half width of rail from L, and draw parallel with L V, cutting the bevel. This gives V 2 for half width of mould at each joint, and the points through which curves on mould must pass.

Fig. 2. Find the mould for landing wreath, to stand over three risers from joint C. Make B E equal tangent B C; Square up from E; make E F equal the height of three risers; draw from B through F. This is pitch of tangent D S on mould. Draw from F the floor, and above this set off half a riser; draw under side of level rail; set off half its thickness, cutting the pitch at H; from H draw parallel with F E, cutting at J. This gives J H for height of wreath. Make C L equal B J; Draw from L, touching centre of rail, as K; prove this line by drawing from K through centre O. Then L K to be correct must stand at a right angle with K O. Proceed by drawing from C parallel with L K; make height J P equal height J H Fig. 2; draw from P through K. This is pitch of plank. Draw from P and K square with the pitch; make P B equal J C, and make K H equal K L; join B H. This is tangent on the mould, and to be correct must equal the pitch B H Fig. 2. Draw any number of lines through width of rail on plan cutting the pitch, and from intersections thus given, draw square with the pitch. Now find points through which trace the curves on mould as shown. The bevel W in angle of pitch applies to upper joint on wreath as K. To find a bevel for joint B, Draw P R parallel with tangent B H on mould; From any point as 2, draw square with the pitch, cutting at 3; take 2 as centre, and a radius touching P R; strike an arc cutting V; draw from 3 through V. This gives bevel X for lower joint on wreath. The square sections of plank show the application of these bevels to joints. To give the method for a piece of wreath starting, would be a repetition of the landing wreath.

Plate 32

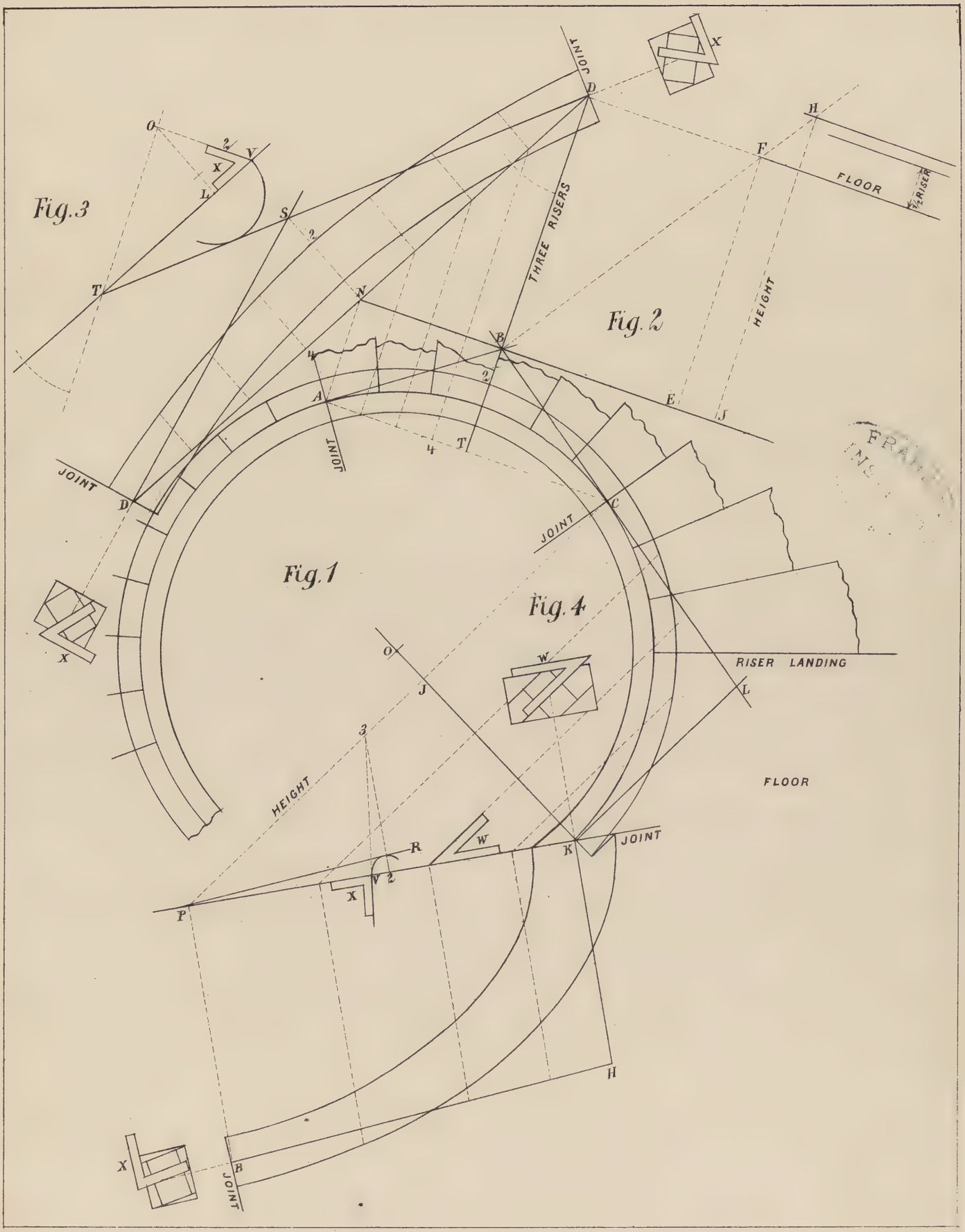
Fig. 3
Fig. 2
Fig. 1
Fig. 4
JOINT
THREE RISERS
HEIGHT
FLOOR
RISER
RISER LANDING
JOINT
JOINT
JOINT
JOINT
HEIGHT
FLOOR
JOINT
O
V
X
L
S
T
N
D
A
B
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